EVALUATING THE APPROPRIATENESS OF BLOOD COMPONENT UTILIZATION IN BURNS PATIENTS

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ABSTRACT

BACKGROUND AND AIMS:

Blood transfusion is a common intervention in critically ill surgical patients, especially Burns patients. But transfusions have potentially life threatening risks. The aim of the study was to evaluate the appropriateness of various blood components, utilized in Burns patients and also to evaluate the relationship between age of red blood cells and wound healing.

MATERIALS AND METHODS:

Burns patient who were more than 16 years, with 15 – 40% Total body surface area burns and had survived treatment were included for a period of one year (September 2014 – August 2015). New York State health guidelines for RBC transfusion in Burns, Baxter's original Parkland formula and platelet transfusion thresholds given by the American Association of Blood Banks (AABB) were used to categorize appropriate transfusions from inappropriate transfusions. Length of hospital stay was taken as the measurable outcome for wound healing and the factors influencing Length of stay were analysed.

RESULTS:

A total of 122 burns patients who fulfilled the inclusion criteria were followed. 85 patients received 308 red cell units of which 64% were appropriate. 114 patients were transfused with 441 fresh frozen plasma units of which 47%

were appropriate. One patient was transfused with platelet concentrate and all patients, who had their platelet count more than 10,000/µL, were not transfused.

The factors found to significantly increase the length of stay included the APACHE II score at admission, Red cell transfusions, surgical procedures and wound infections. The factors not significantly influencing Length of stay were age of the burns patient, sex and storage age of red cells.

CONCLUSION:

In our study, 64% of red blood cell transfusions and 47% of FFP transfusions were appropriate. As the storage age of red blood cells had no significant influence on length of stay, there is no rationale in ordering fresher whole blood to aid in wound healing. Length of stay for burns patients significantly increases following blood component transfusion. Successful outcome of burns patients purely depends on proper wound care, along with appropriate use of fluids and blood components.

Keywords:

Burns, Appropriate, Length of stay, RBC storage age

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ABBREVIATIONS

AABB	American Association Of Blood Banks
ACS	Abdominal Compartment Syndrome
APACHE II	Acute Physiology And Chronic Health Evaluation II Score
ARDS	Acute Respiratory Distress Syndrome
EMS	Emergency Medical Services
FFP	Fresh Frozen Plasma
FNHTR	Febrile Non Hemolytic Transfusion Reactions
HB	Hemoglobin
HES	Hydroxyethyl Starch
HIV	Human Immunodeficiency Virus
HTR	Hemolytic Transfusion Reaction
IDR	Intake Diuresis Ratio
LOS	Length Of Stay
NCRB	National Crime Records Bureau
NIH	National Institutes Of Health
NPPA	National Pharmaceutical Pricing Authority
NPPBI	National Programme For Prevention Of Burn Injuries
PBD	Post Burn Day
PRBC	Packed Red Blood Cells
RBC	Red Blood Cells
RL	Ringer's Lactate
SD	Standard Deviation
% TBSA	Percent Total Body Surface Area burnt
TMAG	Transfusion Medicine Advisory Group
TRALI	Transfusion Related Acute Lung Injury
TRIM	Transfusion Related Immuno Modulation
TTI	Transfusion Transmitted Infections

INTRODUCTION

Red blood cell transfusion is a common intervention in intensive care units with approximately one third of critically ill patients receiving a blood transfusion at one time or another during their stay.[1] A significant number of surgical patients are exposed to the potential risks of blood transfusion where hemolytic transfusion reactions and transfusion-transmissible infections can be life-threatening.[2]

Tolerance to anemia is highly dependent on the volume status of the patient, physiological reserve and the dynamics of anemia, as normovolemic anemia is better tolerated than anemia in hypovolemic states.[1]

The criteria for optimal anemia management are not clearly defined even though transfusions are more prevalent in ICU patients. The transfusion trigger of hematocrit 30% or hemoglobin 10 gm/dL was first suggested in 1942, which is still being followed in many centers, even though clinical trials over the past two decades have shown equivalent outcomes with a conservative transfusion threshold of hemoglobin level of 7 gm/dL, in critically ill patients. [3]

While India has an estimated annual blood requirement of 12 million, the annual collection stands at 9.8 million, of which 84 % are collected from voluntary donors.[4] So, adequate inventory of blood is still a significant and chronic concern which further compounds liberal transfusion practice.[2]

The cost-effective approach to reduce the use of allogeneic blood transfusion is to improve appropriateness of transfusions, as new guidelines recommend that decisions to transfuse be based primarily on clinical

assessment of individual patients rather than arbitrary hematocrit thresholds. The rates of inappropriate transfusions have varied from 0.3 to 49.6% because of the differences in criteria used to define appropriate and inappropriate transfusions.[3]

Burns patients suffer possibly the greatest initial hemodynamic and metabolic stress of all the surgical critically ill patients with the duration of illness lasting for weeks and months. Conditions that necessitate transfusions related to anemia in burns patients are not clearly defined.[5]

This study was undertaken to find out the appropriateness of blood usage pattern in Burns patients which will help the Burns treatment team to utilize the invaluable resource appropriately, predict future blood demand and help maintain transfusion inventory for specialized burns units.

AIMS AND OBJECTIVES

AIM:

To evaluate the appropriateness of blood component utilization in Burns patients admitted in Burns ward, Kilpauk Medical College and Hospital, Chennai, Tamilnadu.

OBJECTIVES:

- To evaluate the appropriateness of various blood components utilized in Burns patients.
- To evaluate the relationship between age of red blood cells and wound healing.

REVIEW OF LITERATURE

Skin:

Skin is the largest organ in the human body, weighing about 6 to 10 kg with surface area of 1.5 to 2 square meters in an adult male. Epidermis is thinner over eyelids and thicker over soles of feet while dermis is thickest over the back. Infants, children and the elderly have thinner dermis making them more prone for deeper burn injuries.[6]

Skin has varied functions like protection of underlying tissues, prevention of water loss, regulation of body temperature, synthesis of vitamin D and also as a sensory organ. Skin also takes part in immunological function with its rich supply of Langerhans cells, Keratinocytes, Lymphocytes and Mast cells.[7]

As skin functions as a barrier to microbial invasion, the size of burn injury correlates well with burns wound infection and systemic infection.[6]

Burns:

Burns is caused by overheating of body tissues above the critical temperature, leading to tissue damage.[7] Burns is a major cause of morbidity and mortality worldwide which rises with increasing burned surface area and age. Even small burns can become fatal in the elderly.[8]

Burns are classified as first, second and third degree but it is common to find all three types within the same burns wound, where depth changes with time, especially if infection occurs.

Table 1: Characteristics of various degrees of burns: [8]

Depth of burns	Characteristics	Cause
First degree burns	• Erythema • Pain • Absence of blisters	• Sunburn
Second degree burns (partial thickness)	• Red or mottled • Swelling and blisters • Painful	• Contact with hot liquids • Flash burns
Third degree burns (full thickness)	• Dark and leathery • Dry • Sensation only at edges	• Fire • Electricity or lightning • Prolonged exposure to hot liquids/objects

Serious burns requiring hospitalization:[8]

- Greater than 15% burns in an adult
- Greater than 10% burns in a child
- Any burns in the very young, the elderly or the infirm
- Any full thickness burns
- Burns of special regions: face, hands, feet or perineum
- Circumferential burns
- Inhalation injury
- Associated trauma or significant pre-burns illness: e.g. diabetes

Burns involving the face, airway or genitalia are classified as major burn injuries regardless of % Total Body Surface Area burns (% TBSA) affected.[9]

First degree and superficial second degree burns are usually treated with daily dressing changes, medications, blood products like fresh frozen plasma and packed red cells along with protein and vitamin enriched diet and do not need surgical intervention. Deep second and third degree burns generally require surgeries like escharotomy, wound debridement, skin grafts and amputation.[10]

Burns in the world:

An estimated 265,000 deaths occur in the world every year caused by burns[11] of which Southeast Asia contributes to nearly one half of the total number of fire related burn deaths worldwide.[12] Non- fatal burns are a leading cause of morbidity.[11]

Burns in India:

India, with over a billion population, has an estimated annual burns incidence of 6-7 million, thus accounting as the second commonest cause of injuries after road traffic accidents. Even though 90% of burns are preventable, 10% of these burn injuries are life-threatening and 50% of the hospitalized patients die of their injuries. Nearly 70% of burns victims are in the 15 to 40 age group who are most productive but belong to poor socioeconomic status. National data on burns are scarce as it is not a notifiable disease and central registry is nonexistent.[13] Burn injuries continue to be a problem due to poor access to medical facilities and lack of specialist doctors.[14]

The National Programme for Prevention of Burn Injuries (NPPBI) has been initiated in India to reduce the incidence of burns and to effectively utilize

available resources for standardized treatment delivery. The programme has three components, namely, Preventive programme, Burns injury management programme and Burns injury rehabilitation programme. For burns injury management, existing medical facilities are upgraded and utilized while capacity building will be made in non-existent facilities.[13]

Magnitude of the Burns problem:

According to National Crime Records Bureau (NCRB) reports, total accidental deaths in 2013 were 4,00,517 of which total deaths due to accidental fires are 22,177 (6.6%) with electrocution adding another 10,218 (2.6%) of accidental deaths. Tamil Nadu accounts for 8.3% and thus shares a larger percentage of accidental deaths, at third place in our country. [15]

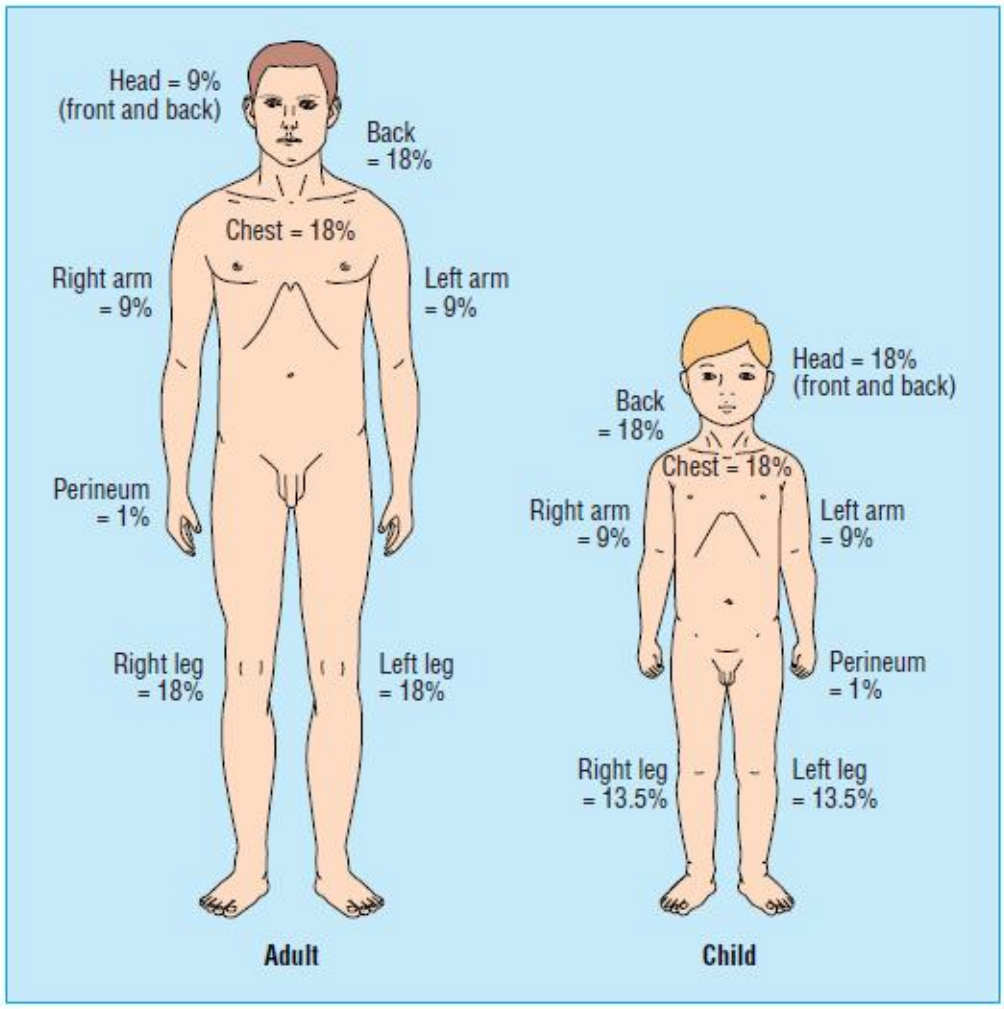
Deaths due to Fire/Self-immolation account for 7.4 % of all suicides (1,34,799) in India, being the third prominent means of committing suicides. Tamil Nadu accounts for 12.3% of all suicides in India, the second highest after Maharashtra. The share of female victims was higher (63.1%) in suicides by Fire/Self-immolation.[16]

Illiteracy, high poverty and crowding in urban areas contribute to unsafe living conditions. Inadequate access to health care facilities cause a delay in presentation to specialized burns units.[17] The costs of treatment in specialized burns units are very high which further restricts the common man's reach.[14]

Children and their parents should be educated about fire safety, storage and safe handling of flammable fluids and gases (especially cooking stoves) and first aid for flame burns and scalds.[17]

Total Body Surface Area burns (TBSA) calculation:

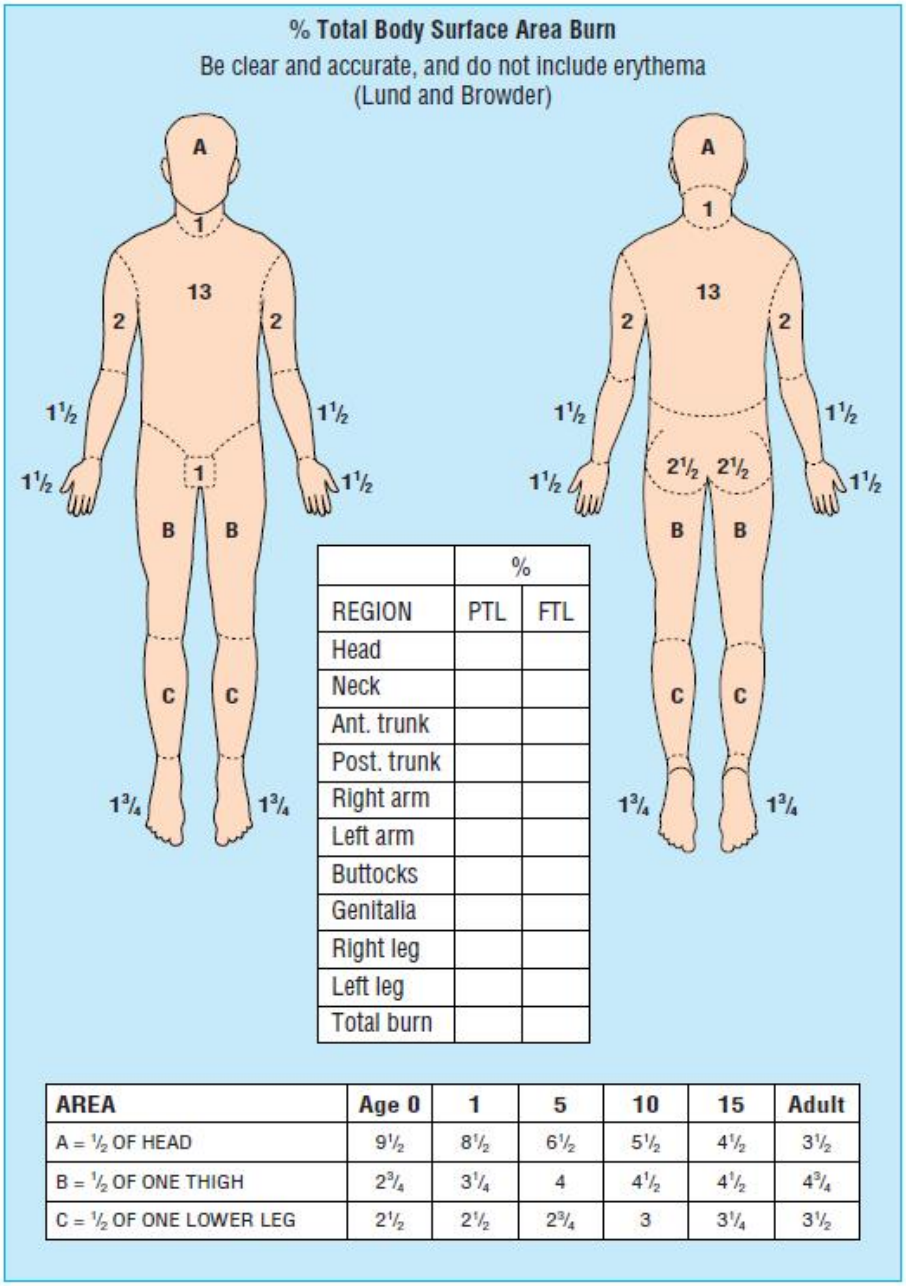
Burns size is assessed using the Wallace rule of nines or the Lund and Browder chart.[18,19]



Wallace rule of nines

Fig 1: % TBSA calculation based on rule of nines [18]

Wallace rule of nines is a good, quick way of estimating medium to large burns in adults, though it is not accurate in children. The body is divided into areas of 9% and the % total body surface area burns is calculated. [18]



Lund and Browder chart

Fig 2: % TBSA calculation based on Lund and Browder chart[18]

This chart, if used correctly, is the most accurate method. It compensates for the variation in body shape with age and therefore can give an accurate assessment of burns area in children.[18]

Mortality increases as the degree of burns and total body surface area burns increase i.e. 0.25% mortality risk with less than 10% TBSA, 5.4% risk with 20-39% TBSA and 96.6% risk for >90% TBSA. Mortality was observed more in greater than 40% burn injury.[20]

Burn injury pathogenesis:

Burn injury evolves in two phases, a burns shock phase followed by a hypermetabolic phase. There is an increased microvascular permeability, vasodilatation, vascular stasis and reduced cardiac output resulting in massive edema formation in both injured and non-injured tissues, within 6-8 hours of burns. This shock phase is followed by a massive surge in catecholamines and corticosteroids, greater in non-burned tissues, which results in a hypermetabolic state with increased myocardial oxygen consumption, systemic hypertension, muscle degradation, insulin resistance and liver dysfunction.[9]

Burns tissue release inflammatory mediators like histamine, prostaglandins, kinins, thromboxane and nitric oxide, which increase in the early hours after burn injury and result in increased capillary permeability and local edema. Subsequent reperfusion results in reactive oxygen species and toxic cell metabolites which propagate immune response.[9]

Hyperventilation occurs in hypermetabolic phase and persists till wound closure. Proteins and amino acids are mobilized to meet the increased metabolic needs resulting in significant loss of lean body mass, which further impairs immune function and wound healing.[9]

Inhalation Injury:

Inhalation injury of the lung is proportional to the depth and extent of TBSA and along with cutaneous burns, increases fluid resuscitation requirements, pulmonary complications and overall mortality. This injury can be divided into three classes: 1) heat injury restricted to upper airway above the glottis, which lead to massive edema and obstruction, 2) local chemical irritation throughout the respiratory tract, which damage type II pneumocytes and impairs surfactant production and 3) systemic toxicity due to carbon monoxide or cyanide, by compromising oxygen delivery. Mucus and cellular debris form casts, which can obstruct moderate size airways when mucosa sloughs. [6, 21]

History of entrapment in a closed space, facial burns, symptoms of respiratory distress with the presence of singed nostril hairs and carbonaceous sputum point to probable inhalation injury.[9, 22, 23] As the oropharynx and nasopharynx dissipate heat effectively, thermal injury is primarily restricted to airway structures above the vocal cords, unless steam is inhaled.[9]

Fluid loss in Burns:

Before recognition of the magnitude of fluid shifts and massive fluid requirement in Burns, failed resuscitation was the leading cause of death. The primary goal of burn resuscitation is to maintain adequate tissue perfusion and prevent ischemic injury, especially acute renal failure.[24] Burns patients suffer possibly the greatest initial hemodynamic and metabolic stress and duration of their critical illness can last from weeks to months. [5]

Loss of fluid in burn injury was the result of active transport of water across the capillary wall rather than increased capillary permeability. This increased permeability is also seen in areas distant from burns site.[25, 26] Disrupted capillary integrity allows for rapid equilibration of water, inorganic solutes and plasma proteins between intravascular and interstitial spaces which lead to intravascular hypovolemia and hemoconcentration that are maximal at 12 hours postburns.[27]

Leakage and accumulation of plasma proteins in the extravascular compartment contribute significantly to tissue edema formation. It takes about 12 hours for the protein leakage to cease significantly.[28]

Patients with burns involving less than 20% TBSA for adults and 10-15% TBSA for children can be treated successfully with oral fluids alone. [28] Under resuscitation leads to decreased perfusion, acute renal failure and death while over resuscitation leads to “fluid creep” which in turn leads to worsening edema, Acute Respiratory Distress Syndrome and multiple organ dysfunction [27]

Crystalloid solutions alone are sufficient to acutely resuscitate most uncomplicated burns patients up to 20 to 25% TBSA. Parkland described the use of isotonic crystalloid solution, Ringer’s Lactate, at a dose of 4 ml/kg/% of TBSA during the first 24 hour post burn to maintain a urine output of 30 to 50 ml/hour. One half of the total fluids calculated are administered in the first 8 hours and the rest is administered over the next 16 hours. [24] Ringer’s Lactate contains 130 mEq/L of sodium, which is slightly hypotonic, but it effectively treats both hypovolemia and extracellular sodium deficits caused by thermal injury. [27]

Adults and children with burns greater than 20% TBSA should undergo formal fluid resuscitation to maintain a urine output of 0.5-1.0 ml/kg/hr in adults and 1.0-1.5 ml/kg/hr in children, [a mean hourly urine output of approximately 50 mL/hr in the first 24 hours and 100 mL/hr during the next 24 hours]. [27, 29] Urinary output is an unreliable guide for patient's hydration status > 48 hours after burn injury, as respiratory water loss, osmotic diuresis by glucose and hormonal derangements contribute to increased fluid losses despite an adequate urine output.[30]

The addition of colloids after the first 12-24 hours post burns, may decrease overall fluid requirements, as capillary integrity is sufficiently restored at about 24 hours post burns. [27] The main colloids used for burns resuscitation are Human albumin, the most oncotically active colloid and Fresh Frozen Plasma (FFP), which contains clotting factors, along with proteins.[28]

Fresh frozen plasma is often used in children, and albumin or synthetic high molecular weight starches are used in adults. [18]

Licensed indications for human albumin solutions are emergency resuscitation of shock, acute management of burns and conditions associated with hypoproteinemia. As human albumin has limited availability and high cost, its use should be restricted to proven indications. [31]

Fresh frozen plasma is probably the best colloid solution for acute burns resuscitation, particularly when there is a risk of coagulopathy. However, the main drawback is that it carries the risk of transmission of infection. [24] Plasma transfusions are a rational treatment for restoring protein level due to the fluid shift. [26]

One of the thresholds for plasma transfusion is the presence of active bleeding from wounds.[23] Fresh Frozen Plasma continues to be used as prophylaxis, before surgery or invasive procedures, even in the absence of clinical bleeding. But the effectiveness of FFP remains unanswered.[32]

Colloids – Beneficial or Detrimental?

Colloid based resuscitation was excluded from Baxter's original Parkland formula by National institutes of Health (NIH) consensus.[33, 34] The advantages of protein based colloids in burns resuscitation are reduced tissue edema in both burnt and non-burnt tissues, which reduce the incidence of compartment syndrome and fasciotomy, and lesser chance of ileus. Disadvantages include higher costs of albumin; anaphylaxis with dextrans, acute renal injury with Hydroxyethyl Starch (HES); possible anaphylaxis, Transfusion-transmitted Infections (TTI) and Febrile Non hemolytic transfusion reaction (FNHTR) with Fresh Frozen Plasma.[24,28,35,36]

The higher risk of mortality among burns patients receiving colloids could possibly be attributed to the fact that patients included in the studies were often more critically injured and their mortality can only be ascribed to a combination of multiple factors and co-morbidities rather than colloids. Recent reports, while refuting the assumption that resuscitation with colloids in burns patients is harmful, give differing data to say that colloids improve survival.[24,37,38]

Albumin might increase the risk of death in patients with hypovolemia, burns and hypoproteinemia. The reason for this increased mortality with albumin is that albumin is believed to have anticoagulant properties, inhibiting platelet aggregation and enhancing the inhibition of factor Xa by Anti-Thrombin III. Furthermore, albumin can distribute across capillary membrane and this increased leakage into the extravascular space reduces oncotic pressure difference, making edema more likely.[31]

With advanced and scrupulous screening of blood components, fresh frozen plasma can be more beneficial than detrimental, for burn resuscitation.[28]

Burns and Transfusion:

Blood transfusion has become ubiquitous in treating major burn injury (> 20% TBSA burn), [39] as red blood cell (RBC) transfusion is one of the few treatments that adequately restore tissue oxygenation especially when oxygen demand exceeds supply.[40]

Improvement in donor blood screening procedures and implementation of stringent quality measures has improved the safety of allogeneic transfusion, especially in more developed countries.[40]

Duration of hospitalization was prolonged in burns patients who were transfused with allogeneic blood components and with advancing age. Fresh plasma is necessary in low plasma protein levels while red cells are necessary for oxygen delivery to injured sites.[41]

Burns patients, not receiving blood transfusions, had fewer complications than patients receiving transfusion due to the fact that those not receiving transfusion have smaller burn injury and less inhalation injury. Survivors required fewer escharatomies and fasciotomies.[39]

It has been estimated that 117 ml of blood volume is lost for every 1% of body surface area excised and grafted.[42] While total red cell transfusions were associated with % TBSA, Acute physiology and chronic health evaluation (APACHE II) score and number of surgical interventions, transfusions specifically related to the anemia of critical illness were associated with the initial APACHE II score.[5]

The specific level of hemoglobin or hematocrit, which dictates when to transfuse red cells is known as the 'Trigger'. But there is no one 'common trigger' with values ranging from 6 gm% to 8 gm% in different centers.[42]

Historically, the transfusion threshold for RBCs was hemoglobin below 10.0 gm/dL or hematocrit below 30%, which was first proposed by Adams and Lundy. After 1988, when the National Institutes of Health consensus conference in the United States did not find evidence to support a single criterion for transfusion, several guidelines were published, recommending a range of hemoglobin values between 6.0 to 10.0 gm/dL.[40]

Numerous trials have shown that a restricted blood transfusion protocol (to maintain a hemoglobin of 7-9 gm %) has a lower mortality, cardiac complication and organ dysfunction compared with liberal transfusion (to maintain Hb of 10-12 gm %).[42]

Despite modifications to transfusion thresholds over the past 20 years, transfusion thresholds still differ between various burns centers.[5] In patients without cardiac compromise, blood transfusion can be withheld to hemoglobin levels as low as 7.0 to 8.0 gm/dL as long as there is no active bleeding.[40] Blood transfusions are necessary in burn patients losing more than 700 ml at any one time or have a fall in Hemoglobin to 8 gm%.[41]

There is neither an optimal transfusion protocol nor a discrete transfusion trigger. An important consideration for blood transfusion is acute blood loss with the signs of hemodynamic stability. Bedside clinical signs like blood pressure, heart rate, fall in urine output and change in mental status have been proven to be insensitive and nonspecific. Coagulopathy can be prevented by preventing hypothermia, timely use of fresh frozen plasma and correcting acidosis.[42]

Younger patients and less ill patients were harmed by Red cell transfusion while older and more ill patients benefited. The benefit of conservative strategy was greater among younger patients and those with the APACHE II score <20. Thus, Universal transfusion protocols may be harmful, but RBC transfusion should not be viewed as uniformly hazardous.[3]

Complications can prevent early wound healing. Delayed wound healing leads to prolonged hospital length of stay.[43]

Age of red blood cell storage and clinical outcomes:

Red blood cells are stored upto a maximum of 42 days after donation and the storage lesions in red blood cells after prolonged storage is a well

proven fact. But there is uncertainty on the clinical consequences of fresher or older red blood cell units stored for different durations before transfusion. The clinical outcomes of interest were death, length of hospital stay, incidence of infections and body functional assessment. Ville Pettila *et al.*[44] for the Australian and New Zealand Intensive Care Society (ANZICS) group have found that older red blood cells are associated with increased mortality in critically ill patients. But other studies from AABB technical manual and Cochrane review failed to find a conclusion that clinical outcomes differed with different durations of storage.[45, 46, 47]

Appropriateness of Red blood cells Transfusion:

The appropriateness to transfuse blood include not only the pre-transfusion hemoglobin levels, but also events like ongoing blood loss followed by symptoms and signs in the patient like changes in blood pressure and heart rate. Post-transfusion hemoglobin and documentation of informed consent for transfusion also signify appropriateness.[2]

A loss of less than 15% of blood volume does not require blood transfusion unless there is pre-existing anemia. Patients with Hb concentrations below 6 gm/dL almost always require red cell transfusion. In those with Hb between 6 and 10 gm/dL, the decision to transfuse is based on clinical status evaluation. Patients with Hb values above 10 gm/dL rarely require transfusion. Another guideline gives a trigger of $\leq$ 8 gm% in burns patients who are not critically ill and without cardiopulmonary compromise.[48,49,50] However, decision is made taking other factors into consideration: type of surgery, extent

of blood loss, presence of adverse clinical conditions (age of patient, cardiopulmonary compromise).[48,49,51,52,53]

Among patients in intensive care, restrictive transfusion threshold with Hb values between 7-8 gm/dL does not increase mortality, morbidity or duration of hospitalization. Exceptions to restrictive threshold include patients with cardiovascular disease.[51]

Inappropriate uses of Red blood cell transfusion include a) Anemia with Hb above 10 gm/dL, b) to expand the circulatory volume, c) to replace hematinics and d) to accelerate wound healing.[51]

Monitoring indices for clinical auditing include use of red cell transfusion in anemia with Hb > 10 gm/dL and to expand circulatory volume.[51] Various studies show the appropriateness of RBC transfusions varying from 97% to 54.1%. [3,54,55]

Appropriateness of Plasma Transfusion:

If plasma unit is prepared from the unit of collected whole blood and frozen within eight hours from donation, the unit is termed fresh frozen plasma (FFP).[56] The typical adult dose of plasma is 10 ml -15 ml per kilogram of body weight.[57]

According to the Transfusion Medicine Advisory Group (TMAG) of British Columbia, inappropriate uses of Fresh Frozen Plasma include use in hypovolemia (intravascular volume expander), to enhance or promote wound healing, as a nutritional support, protein losing states or in Burns.[57]

Inappropriate indications for Fresh Frozen Plasma include expansion of circulatory volume, hypoproteinemia and for nutritional purposes.[51] Other inappropriate use is insufficient volume transfused.[56]

Monitoring indices for clinical auditing are; a) use of FFP in situations like expansion of circulatory volume, hypoproteinemia and for nutritional purposes and b) evaluating the appropriateness of the dose of FFP.[51] Various studies show inappropriate FFP transfusions ranging from 22.7% to 52%.[56,58,59]

Appropriateness of Platelet transfusions:

The current recommendations for platelet transfusion is 10,000 platelets/μL in clinically stable patients.[51] The surgical patient with active bleeding usually requires platelet transfusion if the count is < 50,000/μL. [51, 60]

Monitoring indices for clinical auditing include prophylaxis at a transfusion threshold, which was higher than recommended.[51]

Burns Treatment Centres:

A burns center must be well equipped and requires the collaboration of various specialties including plastic and reconstructive surgeons, infectious disease specialists, anesthetists, dieticians, psychologists, pediatricians, physiotherapists, microbiologists and epidemiologists. The importance of nursing needs no special mention. [10]

Cause of Burns:

Burn injuries are a major public health problem due to its high mortality, morbidity and disability among young and middle aged adults. It may be accidental, suicidal or homicidal.[61] Flame was the most common cause of burn injury followed by scald, electrical and chemical burns. Burns was more common in females. Every 1% increase in TBSA is significantly associated with a 6% increase in risk of mortality.[61,62]

Age of the burns patient:

Advanced age is a risk factor for late post-burns unfavorable outcomes.[10] Advancing age poses significant challenges after burns, as elderly patients have increased risk of mortality and on average require two times the length of hospitalization.[63]

Body temperature in Burns patients:

A crucial point that is overlooked in burns is maintaining body temperature. Hypothermia contributes to coagulation or platelet dysfunction and increases the need to transfuse blood components. Measures like maintaining a higher ambient temperature, covering of exposed skin, using warm blankets or radiant heaters help to effectively maintain core temperature of the burns patient.[42]

Burns and electrolytes:

Changes in capillary permeability have been demonstrated in both burned and unburned tissues contributing to leakage of intravascular

components into the extravascular space. Cellular membrane permeability leads to intracellular sodium accumulation and consequent cell swelling. [28] Disruption of transmembrane sodium–ATPase activity presumably leads to rise in intracellular sodium which contributes to hypovolemia and cellular edema. [27]

Burns and platelet levels:

Thrombocytopenia is present in most burns wound infections in addition to fever (temperature > 38.4^0 C) and leukocytosis (white blood cell count > 10,000 cells/cu. mm).[6] Free radicals released by acute burns result in oxidation of proteins (oxidatively modified proteins) of which oxidized albumin increases aggregation of erythrocytes and platelets.[64]

Declining platelet count occurs very early in septicemia even before clinical signs and symptoms develop. Thus thrombocytopenia can be an early indication of bacteremia in burns patients. Rebound rise in platelet count on subsequent post-burns days occurred in burns survivors and the platelet count was not dependent on the extent of burn injury. So, serial platelet count in post-burns period can be a prognostic indicator in burns patients.[65]

Metabolism in Burns:

Metabolic response to burns injury has two phases: initial *ebb* stage, where there is a deficit in plasma volume and insulin levels, shock, hypothermia and decreased overall metabolic rate. This is followed by a *flow* stage, characterized by a rise in catabolic hormone concentration, resulting in tachycardia, fever, proteolysis, gluconeogenesis and increased overall metabolic rate.[66]

Hypermetabolism begins at about fifth post-burns day and can persist for an year leading to loss of lean body mass and reduced bone mineral density. Metabolic response in patients with more than 40% TBSA is 100% above resting metabolic rate.[66] In general, 10% loss of total body mass leads to immune dysfunction; 20%, to decreased wound healing; 30%, to severe infections; and 40%, to death.[67]

Early nutritional support is a critical component of management of injured patients, to prevent ileus, stress ulcers and effects of hypermetabolism. They also had a shorter stay in the Intensive Care Unit and lower wound infection rates.[68]

Patients who have severe burns, have active catabolism and high levels of energy consumption that can result in progressive weight loss, immune dysfunction, visceral organ dysfunction, delayed wound healing or even death. Adequate and rational nutrition helps to ameliorate nutritional status, reduce complications and thus improve prognosis of burns patients. While underfeeding leads to catabolic complications with poor prognosis, overfeeding increases metabolic burden and aggravates organ dysfunction.[69]

Even though many formulae exist for estimating energy needs of burns patients like Pennisi, Toronto, Schofield, Harris-Benedict and American Society for Parenteral and Enteral Nutrition (ASPEN) recommendations, the simple formula used is the Curreri formula. Harris-Benedict formula is most widely used in children.[66]

Diet consisted of high protein with balanced carbohydrate and fat diet and energy requirement was calculated as per Curreri formula:[7]

Age 16-59 years: (25) W + (40) TBSA

Age ≥ 60 years: (20) W + (65) TBSA

In the Curreri formula, energy estimate for every 1% TBSA is 40 Kcal which is higher than actual consumptions of burns patients. The Milner formula is the most accurate energy estimation formula currently in use clinically and it takes into account the three core factors that affect energy consumption: % TBSA, Post burn day (PBD) and Body surface area (BSA). But formulas can only give a rough range and cannot estimate the actual energy consumptions in patients.[69]

Early enteral nutrition (within 24 hours) of about 30 Kcal/kg/day reduces caloric deficit while 2 g/kg/day of protein intake (15 – 20% of total caloric intake) is required by all critically ill patients in 24 hours.[66]

Burns and serum glucose levels:

Insulin is not just a glucose controlling molecule, but also a therapeutic agent which improves muscle protein synthesis, skin protein synthesis and thereby wound healing, positively balanced energy efficiency and a massive impact on inflammatory and acute phase responses.[70]

The 10- to 20- fold rise in corticosteroid and catecholamine levels thwart insulin action and cause increased lipolysis, proteolysis, gluconeogenesis and energy consumption. This state can last up to 12 months post-burns. Plasma

glucose and insulin levels remain high during hospital stay. This excessively high glucose levels can result in poor morbidity and mortality outcomes.[7, 67] An increase in hepatic gluconeogenesis coupled with insulin resistance results in hyperglycemia.[66]

It is a proven fact that hypoglycemia is associated with increased mortality and morbidity in the critically ill. A glucose range of 90 to 140 mg/dl is ideal for treating burns patients.[70] Insulin, in doses to maintain blood glucose around 120 mg/dL, decreased pro-inflammatory cytokines and increasing anti-inflammatory cytokines due to direct binding of insulin on signal transcription factors.[71]

Carbohydrates provide fuel for wound healing and also have a protein sparing effect. The minimum baseline adult requirement of carbohydrates is 2 g/kg/day, but the maximum rate of assimilation of glucose is 7 g/kg/day in the severely burned. This is due to the fact that although glucose delivery to peripheral tissues increases by up to 3 fold, glucose oxidation is restricted, leading to elevated fasting glucose.[67]

Burns and serum proteins:

The normal level of albumin is 35 – 45 g/L. Albumin loss in acute burns result from protein exudation through burns wound and decreased synthesis in liver, leading to a fall to about 80% of normal albumin and prealbumin levels. Loss of albumin through burns wound is greatest in the first 3 post-burn days, after which they stabilize.[64] Albumin levels in plasma showed a permanent decline which was more pronounced in the fourth and fifth week of hospital treatment.[72]

Soon after burns, there is an increase in metabolic rate leading to protein degradation, muscle wasting and loss of lean body mass. Patients with serum albumin levels at a cutoff point of 21 g/L have a 30% increased risk of 30 day mortality and up to 65% risk of 30 day morbidity.[67]

Partial thickness burns usually blister and protection against fluid loss is lost. A patient's entire amount of serum proteins accumulates in burns wound fluid approximately within 24 hours after a 20% TBSA injury. [30]

Serum albumin levels are inversely related to risk of death for both acute and chronic illness in patients. For each 2.5 g/L fall in serum albumin level, the risk of death increases by about 24% to 56%. [31] Hypoalbuminemia is also associated with prolonged length of stay in Intensive Care. But Albumin level is not a sensitive indicator of protein nutrition state as it has a long half-life of about 20 days. Still it is a reliable indicator of morbidity and mortality in burns patients.[64]

Burns and electrolytes:

Risk factors for serum sodium dysregulation are unconsciousness, parenteral feeding, age and renal insufficiency. In critically ill patients, hypernatremia is associated with adverse outcome. Serum sodium concentration can be used to calculate need of fluid resuscitation during maintenance phase. [30]

Burns and renal parameters:

Patients with better prognosis did not develop acute renal failure and had initial creatinine level less than 1.7 mg/dL.[73] Early changes in renal function can predict inflammatory response and hypoperfusion, which results in mortality.[74]

Leukocyte count in Burns:

Total Leukocyte Count was significantly higher in non-survivors than in survivors at the time of admission but not subsequently. The signs of adverse outcomes were: rise in total leukocyte count by 20% or > 16000 or < 4000.Higher total leukocyte count during hospitalization correlated with infection or sepsis.[7] The inflammatory response after burns is short lived and lasts only a few days, hence the importance of leukocyte level on admission.[75]

Scoring systems in Burns:

A scoring system enables plot of performance over time and becomes a standardized tool which allows for improved research and comparison of therapeutic interventions. A good scoring system can help to provide bedside prognosis, provision of treatment services and to triage patients.[74]

The various prognostic systems are Abbreviated Burn Severity Index (ABSI), Cape Town modified burns score, Ryan score, Burd score, Belgian Outcome in Burn Injury score and laboratory based prognostic scoring which have their own advantages and disadvantages. Although Non Burn specific scoring measures like Acute Physiology and Chronic Health Evaluation

(APACHE) score, Sepsis-related Organ Failure Assessment (SOFA), Simplified Acute Physiology Score (SAPS), Pediatric Risk of Mortality (PRISM) prove their validity in a general Intensive Care Unit and are also helpful as reliable predictors of mortality in burns patients, none of these scores take into account the profound physiological effect of burns itself.

The simple models like APACHE II are still relevant in developing countries like India and shows good discriminating ability between survivors and non-survivors.[76] APACHE II score also has better sensitivity and specificity than clinical evaluation in mixed Intensive Care population.[74]

Burns and Liver:

Liver damage in burns injury results from hypovolemia-related hypoperfusion in the early phase; and sepsis, drug toxicity or blood transfusion in the later phases. Patients with a diagnosis of liver disease were significantly more likely than all other patients to die and required significantly longer lengths of both intensive care and total stay.[77]

Alteration of liver function tests is extremely common following major burns with transient elevation of the aspartate aminotransferase, alanine aminotransferase, and particularly the alkaline phosphatase in 50% of cases. They are usually benign and resolve spontaneously. Elevation of the serum bilirubin is somewhat less common but of more serious consequence. Patients, who show severe and persistent derangements of the liver enzymes, including elevated bilirubin, usually have some associated complication of their burns, such as burns wound sepsis.[77]

Clearance of bacteria by Kupffer cells of the liver normally prevents gut-derived bacteria from entering the systemic circulation. There is a loss of physical barrier function in the gastrointestinal tract after burns injury, which allows translocation of bacteria and endotoxin to the portal circulation, which can lead to multiple-organ failure. The loss of the liver's ability to clear gut-derived bacteria most likely increases the risk of post burns sepsis in burnt patients.[77]

After major burns, hepatic protein synthesis shifts from constitutive proteins like albumin and prealbumin to acute phase proteins, which participate in inflammation and wound healing.[77]

Burns and Nutrition:

The ability of burns patient to handle glucose is limited to 5 mg/kg/day, i.e. for an adult 500 gm or 2000 Kcal/day. High protein intake up to 1.5 gm - 3 gm/kg/day or 20-25% of total energy is the maximum required for burns patients. Fat should constitute no more than 25-30%. Vitamins and minerals should be supplemented. Anorexia and aversion to food are the major factors which hinder intake of calories and proteins. There was no difference in outcome with vegetarian and non-vegetarian diet on clinical outcome.[78]

Burns and Enteral Nutrition:

Even though enteral resuscitation is unreliable and impractical, when gastrointestinal tract is intact and access to medical care is limited, oral resuscitation can be effectively initiated with balanced salt solutions. Oral resuscitation is also appropriate in awake and alert patients with burns < 20%, as the risk of systemic inflammation is low.[27]

Optimal nutrition for the burns patient is best accomplished by early (within 24 hours after injury) initiation of enteral nutrition which modulates the hypermetabolic response by decreasing the circulating levels of catecholamines, cortisol and glucagon.[67] This also led to better nutritional and metabolic parameters, lower body mass index changes, less inflammatory response, lower infection and mortality rates.[72]

Burns and Anemia:

Red blood cells are lost through heat induced damage while Burn injury and fluid resuscitation, in combination, results in anemia and thrombocytopenia during the acute phase. Red cells are also lost through bleeding burns wound, particularly during wound excision and are closely related to burnt surface excised.[9]

The anemia of critical illness is caused by combination of decreased erythropoiesis stemming from decreased erythropoietin production and response, bone marrow dysfunction and poor nutrition; and persistent blood losses due to surgical management of wounds and blood sampling. This anemia occurs usually after 7 days or 21 days in intensive care units. Burns patients suffer, from acute blood losses by the burns injury and subsequent anemia of critical illness, which necessitates blood transfusions for correction.[5]

Hemoglobin value is still the major determinant of the decision to transfuse. During admission, almost 30% of patients had admitting hemoglobin of less than 10 gm/dL. Almost 50% of these patients had neither a history of anemia nor of acute bleeding.[79] Anemia was a strong predictor for ICU

admission and blood transfusion within the first 24 hours. Anemia at the time of admission was associated with age of patient, injury severity and female gender.[80] 95% of patients admitted in Intensive Care Unit have abnormally low hemoglobin levels by ICU day 3.[3]

There was no difference of hemoglobin levels between vegetarian and non-vegetarian diet in burns patients. Iron absorption is aided by high vitamin C content in vegetarian diet.[78]

Complications of Blood transfusion in Burns:

Complications of blood transfusion in burns patients include spread of Transfusion Transmitted Infections (TTI), Transfusion Related Immuno Modulation (TRIM), Transfusion Related Acute Lung Injury (TRALI) and Hemolytic Transfusion Reactions (HTR) among others.[42]

Allogeneic blood transfusion is associated with immunomodulation which includes decreased immune cell proliferation with decreased T cell mediated immunity and thus a predictor of minor wound healing disturbances.[41,80]

In trauma patients, blood transfusion is an independent risk factor for death, perioperative infection, multiple organ failure and admission to Intensive Care Unit. It has been well documented that blood transfusion within 24 hours of admission was an independent predictor of mortality and ICU length of stay.[80]

The harm from RBC transfusion has been attributed to ageing of blood and loss of function due to storage lesion which leads to worsening microcirculation and nitric oxide bioavailability.[3] Packed red cells stored for a long time before transfusion results in poorer oxygen delivery. [41] The number of red cell units older than 14 days and number of units older than 21 days were independent risk factors for multi organ failure, when they were transfused to patients within the first 6 hours of trauma.[80]

The worse outcome in patients who were transfused blood within the first 24 hours of trauma can have the following explanations: Blood transfusion increases the risk of adverse outcome or patients who require blood transfusion have more severe illness and blood transfusion is simply a marker of increased severity.[80]

The development of storage lesions in red cells over time may be responsible for the possible adverse effects of RBC transfusion. The biochemical changes that occur during storage are: a reduction in 2,3-diphospho glycerate, alterations in pH, hypocalcemia, changes in nitric oxide levels, cell lysis and release of free hemoglobin along with increase in cytokines. These changes can increase red cell membrane fragility, compromising microcirculatory flow and inflammatory cytokine release which explain the unfavorable outcomes in critically ill patients. Exposure to even a single unit of older red cells can lead to unfavorable outcome in the critically ill, independent of the volume of transfused red cells.[39]

Evidence suggests that restrictive transfusion while reducing the risk of exposure to RBC transfusion and the total number of units transfused; do not adversely affect function or length of stay. In countries where there is inadequate testing for viral TTIs, it is better to avoid transfusion.[40]

Transfusion Related Immuno Modulation:

Antibiotics cannot eliminate infections without a concomitant adequate host response. An appropriate antibiotic administered for infected burns will not prevent death, even if the organism in the inoculum is highly sensitive in vitro because of depression of host defense mechanism.[81]

The burned patient shows several defects in immune defense mechanism which include: a defect in initial antigen processing, selective increase in IgG catabolism, profound depression of central cell mediated immunity and a suppression of lymphocyte response which enhances skin graft survival. [81]

Blood transfusion complicates the scenario and is an independent predictor of ICU admission, systemic inflammatory response syndrome and hospital length of stay independent of injury severity.[39] Of the deleterious effects of red cell transfusion, the most likely factor to mortality in critically ill is related to immunomodulation rather than allergic reaction or infectious transmission.[79]

Patients who received non-leukofiltered allogeneic blood transfusion experienced postoperative bacterial infections and prolonged length of stay in hospital. The changes in cytokine patterns contribute to increased morbidity in patients receiving even one-time blood transfusion due to immunomodulation.[82]

Even though site of infection was not a risk factor, number of infective episodes correlated with number of blood transfusions with the risk increasing by 13% per unit of blood transfused.[39] Transfusion associated

Immunomodulation is a recognized cause of increased length of hospitalization, antibiotic usage and financial burden in allogeneically transfused patients.[82]

Fresh frozen plasma contains 0.025 gm of albumin/mL and fibronectin which makes it advantageous in early fluid management in burn injury.[83, 84] But even FFP transfusions are also associated with TRIM and its complications, like increased susceptibility to infections and prolonged hospital stay in the critically ill patients.[85]

Burns and Length of stay in hospital:

The true cost of burn injuries, in addition to the monetary cost, includes pain suffered by the patient, work hours lost due to hospital admission, emotional impact on family and friends of the patient, which is impossible to completely measure.[86]

With continued improvement in all aspects of management of burns patients, mortality rates have shown marked improvement and as a result, usefulness of mortality rates as a measure of quality of care and burn service is being questioned. Quality of life and functional status are instead being examined as parameters of burn care, of which hospital length of stay data are easy to collect and measure across different services. They provide an indirect indication of morbidity and clinical complications, as well as cost of care.[87]

The rule of thumb is that length of stay (LOS) in days is roughly equal to value for Total Body Surface Burns.[74] The mean LOS per %TBSA is about 2 days for 20% to 60% burn injury. In patients with burns less than 20% TBSA

the mean LOS per %TBSA is 1.5 days, while in those with more than 60% TBSA, mean LOS per %TBSA rises to 3 days.[75, 86]

Factors contributing to prolonged length of stay in hospital are a delay in hospitalization, deconditioning, social and discharge issues.[63] The gender of the patient was more predictive of length of stay than age.[74] Inhalation injury prolongs the hospital length of stay by three folds. [20] Flame burns require longer hospital stays than electrical and scald burns.[10] Depth of burns was not significantly associated with hospital length of stay. [88] Restricted use of RBC transfusion was not associated with a prolonged length of hospital stay.[40]

The LOS for less severe burns can be paradoxically prolonged because of confounding factors like comorbidities and social circumstances.[87]

Burns and Collagen dressing:

An ideal dressing material for burn wounds has to maintain a moist environment, act as a medium for gaseous exchange while acting as a barrier to bacteria and toxic contaminants. Bovine collagen dressing fulfills this necessity in Burns as it is hemostatic, has low antigenicity and provides mechanical support while forming an essential substrate for cell adhesion and migration. [89]

The advantages of collagen dressing are: ease of availability in various sizes, ease of removal, ability to remain stable at room temperatures for 3 years and cost effective. Only disadvantage is that if placed on flexor surface, it can crack when dry and wound becomes visible. [89]

Burns and Surgical Procedures:

It is estimated that 5% of blood volume is lost for every 1% of TBSA excised and grafted. This high blood loss is because diffuse bleeding indicates that the wound bed is viable and is used as endpoint for excision. [90] Early wound excision (within 24 hours after injury) minimizes blood loss, especially in large burns (> 30% burns), because hyperemia has not occurred.[42]

Escharotomy is the division of burn eschar. A circumferential deep dermal or full thickness burn is inelastic and on an extremity will not stretch. Fluid resuscitation leads to the development of burn wound oedema and swelling of the tissue beneath this inelastic burnt tissue. Thus tissue pressures rise which can impair peripheral circulation. Circumferential chest burns can also cause problems by limiting chest expansion and impairing ventilation. Both of these situations require escharotomy. Only the burnt tissue is divided, not any underlying fascia, differentiating this procedure from a fasciotomy. [18]

Surgery inevitably causes tissue damage resulting in a cytokine mediated inflammatory response via humoral system. Other effects include hypersecretion of catecholamines and pituitary hormones resulting in increased cardiovascular stress and impaired wound healing. These hormonal imbalances also results in a catabolic state.[88]

Early burn wound excision within the first few days of burns has improved survival by reducing risk of systemic inflammatory response syndrome from dead tissue and attenuating the hypermetabolic response by preventing protein loss and sepsis.[90] It also shortens period of wound

inflammation, thus reducing hypertrophic scarring. No more than 20% of burned area is excised during any single procedure.[6]

While large TBSA burn injury patients benefit from surgery, smaller burn injuries rest on a balance between risks and benefits. Benefits include early healing, reduced infections and better scar quality while risks include fatigue, sleep disturbances, hyperthermia, immunosuppression and possible need for blood products.[88]

A major emphasis is placed on blood conservation techniques in surgery/ excision which minimize blood transfusion needs, without sacrificing efficacy of procedures. [90,91]

Burns and sepsis:

There is interplay of pro-inflammatory and anti-inflammatory cytokines resulting in a predominantly anti-inflammatory state, in an effort to restore normal physiology. Complement levels rise to supranormal levels which can cause end organ damage and this is complicated by increased levels of C3b which is immunosuppressive. All the derangements result in increased exposure to pathogens while the immune system is unable to eradicate infections.[6]

Immediate colonization of burn wounds occurs with patient's normal skin flora viz. Staphylococcus aureus and Streptococcus pyogenes which are located deep within sweat glands, within first 48 hours. Subsequent colonization by gram negative flora derived from patient's own gut or respiratory flora or from hospital environment complicates the picture after 5 to

7 days. Pseudomonas aeruginosa is the most common cause of burn wound infection in many centers. Preventing wound infections can result in better outcomes in burns patients with quicker recovery from hospital, as infection preceded multiple organ dysfunction syndrome in most burns patients.[6, 12]

Multiple blood transfusions are associated with risk of Immunosuppression and increased risk of nosocomial infections and hence, reducing transfusions can help benefit patient care. [5, 90] Transfused patients showed relationship between the number of units transfused and risk for nosocomial infections, which rose by a factor of 1.5 for every unit of blood transfused.[80] Risk of infections was 19% higher in patients receiving liberal red cell transfusion.[40]

MATERIALS AND METHODS

Study design:

Prospective Study

Study Population:

Patients admitted and treated in the Burns ward/ Burns Intensive Care unit of Kilpauk Medical College.

Study area:

- Burns ward, Kilpauk Medical College
- Department of Transfusion Medicine, Kilpauk Medical College
- Department of Transfusion Medicine, The Tamilnadu Dr. M.G.R. Medical University, Chennai

Sample size and Study Period:

Burns patients admitted and treated between September 2014 and August 2015, who fulfill inclusion criteria (Purposive sampling) were included in this study.

Inclusion criteria:

- Burns patients (age more than 16 years) #
- Burn size (15 – 40 % TBSA) *
- This study included only Burns Patients who had survived treatment.

(APACHE II score calculation has not been validated in age < 16 years)[74]

* (< 15% TBSA Hospitalization is not necessary [8]

> 40% Mortality Risk Increases) [20, 28]

Exclusion criteria:

Burns patients

- < 16 years.
- Burn size [<15 % & > 40 % TBSA].
- Previously treated and admitted later for reconstructive surgeries.
- Not willing to participate in the study.

Informed consent:

Informed consent from patients/ patients' relatives was obtained for willingness to participate in this study.

Operational Definition

I. Appropriate Use of Blood Components in Burns Patients

To study the appropriate use of blood and blood components in burns patients following guidelines were used.

1. Red Blood Cells

New York State Council on Human Blood and Transfusion Services Guidelines for Transfusion of Red Blood Cells - for Burns Patients.[48]

The following criteria are recommended for RBC transfusion of stable burn patients without active bleeding:

a. For patients not critically ill and without cardiopulmonary compromise, RBCs may be transfused for hemoglobin of ≤ 8 g/dL.

b. For critically ill patients and/or those with cardiopulmonary compromise, RBCs may be transfused for hemoglobin of ≤ 10 g/dL.

2. Fresh Frozen Plasma

Baxter's original Parkland formula[93]

a. Initial 24 hours: Ringer's lactate (RL) solution 4 ml/kg/% burn for adults and 3 ml/kg/% burn for children.

This formula recommends no colloid in the initial 24 hours.

b. Next 24 hours: Fresh frozen plasma given as 20–60% of calculated plasma volume (0.5 ml/kg/%TBSA). No crystalloids. Glucose in water is added in amounts required to maintain a urinary output of 0.5–1 ml/hour in adults and 1 ml/hour in children.

If FFP was given in inadequate doses, it was considered inappropriate transfusions. Transfusion of FFP in the initial 24 hours of burn injury was also considered inappropriate.

3. Platelet concentrates

a. Thrombocytopenia in Burns patients.[91]

i. Thrombocytopenia requiring platelet transfusions is rare in burns patients.

ii. Burns patients with thrombocytopenia can be managed *similarly to any other critically ill patient* with sepsis.

iii. Although platelet transfusions are not common in burns patients, it is necessary to limit its use

b. Platelet transfusion thresholds (AABB): [45]

Table 2: Platelet transfusion thresholds according to AABB:

Indications	**Threshold Platelet count (in cells/µL)**
All patients	10,000
Patients with fever or recent hemorrhage	20,000
Patients with coagulopathy, on heparin, or with anatomic lesion likely to bleed	20,000
Surgical patient with active bleeding	50,000
Intracerebral, pulmonary or ophthalmic hemorrhage	1,00,000

II. Length of stay (LOS) for Wound Healing

1. Age
2. TBSA
3. APACHE II Score (Table 3)
4. Blood Component Transfusion
    i. Total number of Components transfused and LOS
    ii. Storage age of red cells and LOS
    iii. Transfusion of FFP and LOS
    iv. Influence of transfusion on wound infection
5. Surgical Procedures

Delayed wound healing leads to prolonged length of hospital stay [43] and in this study length of hospital stay was taken as the measurable variable.

The age of RBC unit was determined by subtracting the date of collection from the date of transfusion.[44]

Statistical analysis:

Data entry and analysis were done using SPSS software version 21.0. Statistical analysis were done using chi square test (χ^2) and analysis of variance for categorical variables and Pearson correlation (r) to find correlation. $P < 0.05$ was considered significant.

Table 3: APACHE II score calculation chart [94]

The APACHE II Severity of Disease Classification System

Physiologic Variable	+4	+3	+2	+1	0	+1	+2	+3	+4
Temperature - rectal (°C)	≥41	39-40.9		38.5-38.9	36-38.4	34-35.9	32-33.9	30-31.9	≤29.9
Mean Arterial Pressure (mm Hg)	≥160	130-159	110-129		70-109		50-69		≤49
Heart Rate	≥180	140-179	110-139		70-109		55-69	40-54	≤39
Respiratory Rate (nonventilated or ventilated)	≥50	35-49		25-34	12-24	10-11	6-9		≤5
Oxygenation (mmHg) a. $FiO_2 > 0,5$ use $A\text{-}aDO_2$ b. $FiO_2 < 0,5$ use PaO_2	a ≥500	350-499	200-349		<200				
	b				> 70	61-70		55-60	<55
Arterial pH	≥7.7	7.6-7.69		7.5-7.59	7.33-7.49		7.25-7.32	7.15-7.24	<7.15
Serum Sodium (mmol/l)	≥180	160-179	155-159	150-154	130-149		120-129	111-119	≤110
Serum Potassium (mmol/l)	≥7	6-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		<2.5
Serum Creatinine (mg/dl, Double point score for acute renal failure)	≥3.5	2-3.4	1.5-1.9		0.6-1.4		<0.6		
Hematocrit (%)	≥60		50-59.9	46-49.9	30-45.9		20-29.9		<20
White Blood Count (in 1000/mm³)	≥40		20-39.9	15-19.9	3-14.9		1-2.9		<1
Glasgow-Coma-Scale (GCS)	Score = 15 minus actual GCS								
Serum HCO_3 (venous, mmol/l, use if no ABGs)	≥52	41-51.9		32-40.9	22-31.9		18-21.9	15-17.9	<15
A = Total Acute Physiology Score APS	Sum of the 12 individual variable points								

B = Age Points

≤44 years	0 points
45-54 years	2 points
55-64 years	3 points
65-74 years	5 points
≥75 years	6 points

C = Chronic Health Points

If the patient has a history of severe organ system insufficiency or is immunocompromised assign points as follows:

a. For nonoperative or emergency postoperative patients – 5 points

b. For elective postoperative patients – 2 points

APACHE II Score = Sum of A (APS points) + B (Age points) + C (Chronic Health points)

(From: Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med 1985;13(10):818-29)

Table 4: APACHE II score and risk of mortality

APACHE II score	Approximate Mortality Interpretation	
0 - 4	4% non-operated	1% post-operative
5 - 9	8% non-operated	3% post-operative
10 - 14	15% non-operated	7% post-operative
15 - 19	24% non-operated	12% post-operative
20 - 24	40% non-operated	30% post-operative
25 - 29	55% non-operated	35% post-operative
30 - 34	73% non-operated	73% post-operative
35 - 100	85% non-operated	88% post-operative

RESULTS

I. APPROPRIATENESS OF BLOOD AND COMPONENT TRANSFUSION IN BURNS PATIENTS

1. Total blood components utilized in Burns patients:

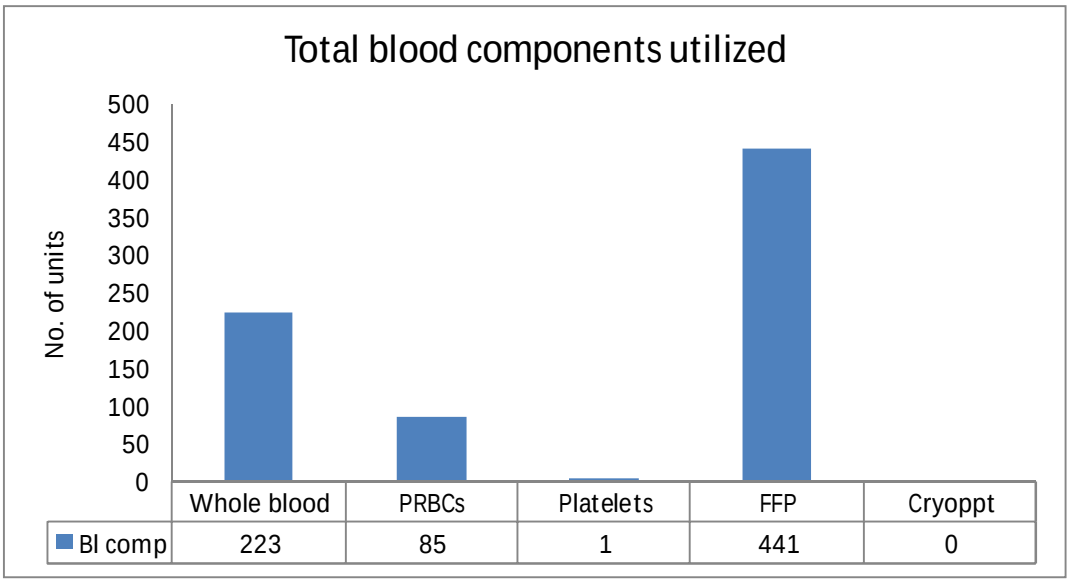


Fig 3: Total blood components utilized in burns patients

(PRBC – Packed red blood cells, FFP – Fresh frozen plasma, Cryoppt – Cryoprecipitate)

In this study population (n = 122), fresh frozen plasma was the commonly used blood component.

2. Distribution of Blood components transfused in Burns patients:

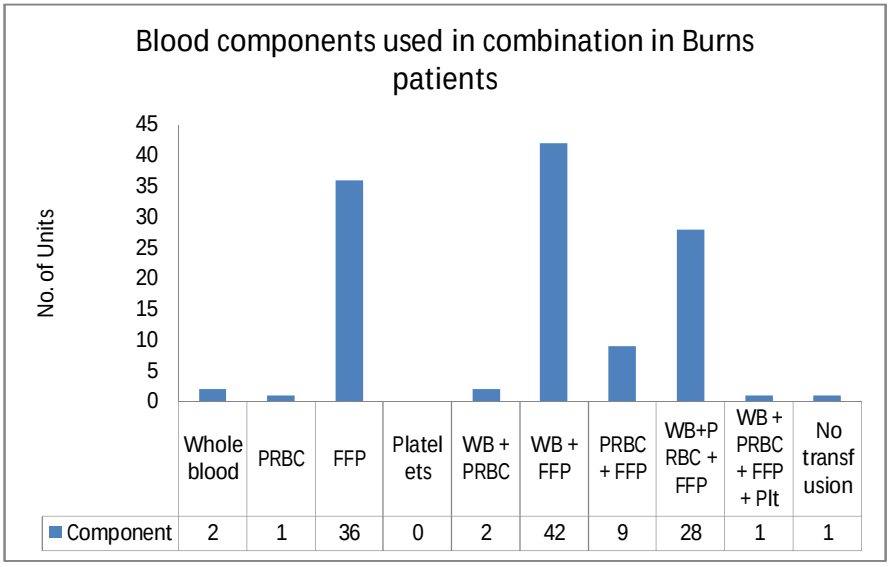


Fig 4: No. of patients for whom various blood components were used in combination

(WB – Whole blood, PRBC – Packed red blood cells, FFP – Fresh frozen plasma, Plt – Platelet concentrate)

In this study population (n = 122), Whole blood with fresh frozen plasma was the commonly used combination of blood components in burns patients.

3. Blood transfusion statistics in Burns patients:

Table 5: Mean and Standard deviation of various blood components used:

Component	Minimum (in number of units)	Maximum (in number of units)	Mean (in number of units)	Std. Deviation
All components (whole blood, PRBC, FFP & PC (n = 121 patients)	1	33	5.75	4.80
Total red blood cells (Whole blood and PRBC) (n = 85 patients)	1	25	3.41	3.19
Whole blood (n = 76 patients)	1	17	2.93	2.39
Packed red cells (n = 41 patients)	1	8	2.08	1.46
Fresh frozen plasma (n = 114 patients)	1	11	3.61	2.51
Platelets Concentrate (n = 1)	0	1	-	-

4. Age of red cells transfused in Burns patients:

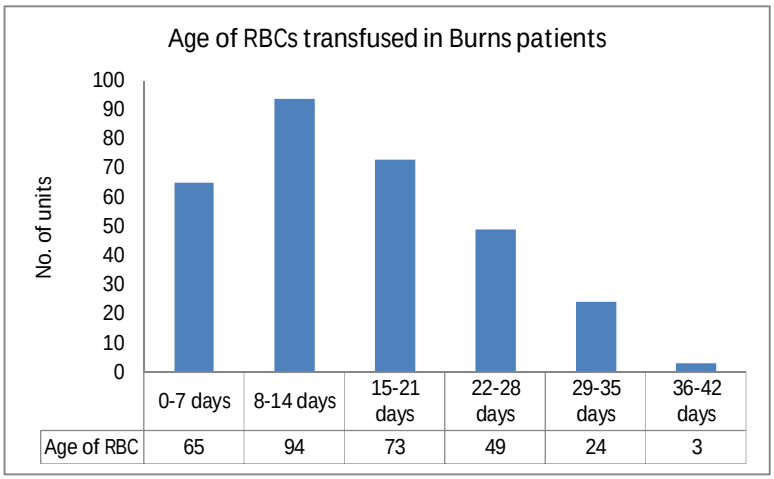


Fig 5: Storage age of RBCs utilized in patients, divided in weeks

In this study population (n = 122), most red blood cell transfusions (whole blood and packed red blood cells) belonged to second and third week of storage (n = 167).

5. Appropriateness of red cell transfusion:

i) Appropriate Red blood cell transfusions based on Hemoglobin trigger:

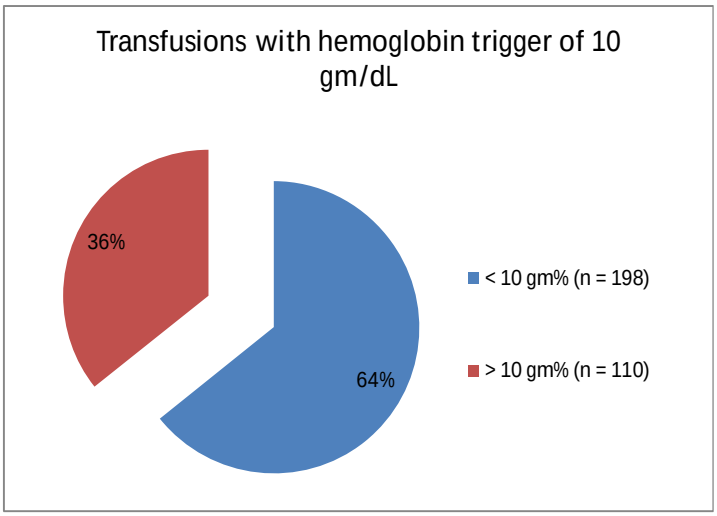


Fig 6: Appropriate transfusions with transfusion trigger of 10 gm/dL

In this study population (n = 122), when a hemoglobin trigger of 10 gm/dL was applied, 64% of all red blood cell transfusions (n = 198) can be considered appropriate transfusions.

The reasons for inappropriate transfusions were:

i) Transfusion when hemoglobin level was > 10 gm/dL

ii) To promote wound healing

ii) Comparison between whole blood and packed red blood cells:

Table 6: Difference in mean LOS between patients transfused with whole blood and PRBC:

Variable **Red blood cell transfusion**	**Length of stay (in days)** **Mean (Std. Deviation)**	**P value**
Patients transfused with only whole blood (n = 44/122)	22.70 (12.06)	> 0.05
Patients transfused with only PRBC (n = 9/122)	21.67 (5.21)	

In this study population, there was no significant difference in mean length of stay between burns patients transfused with only whole blood and those transfused only with packed red blood cells.

6. Appropriateness of Fresh frozen plasma transfusions:

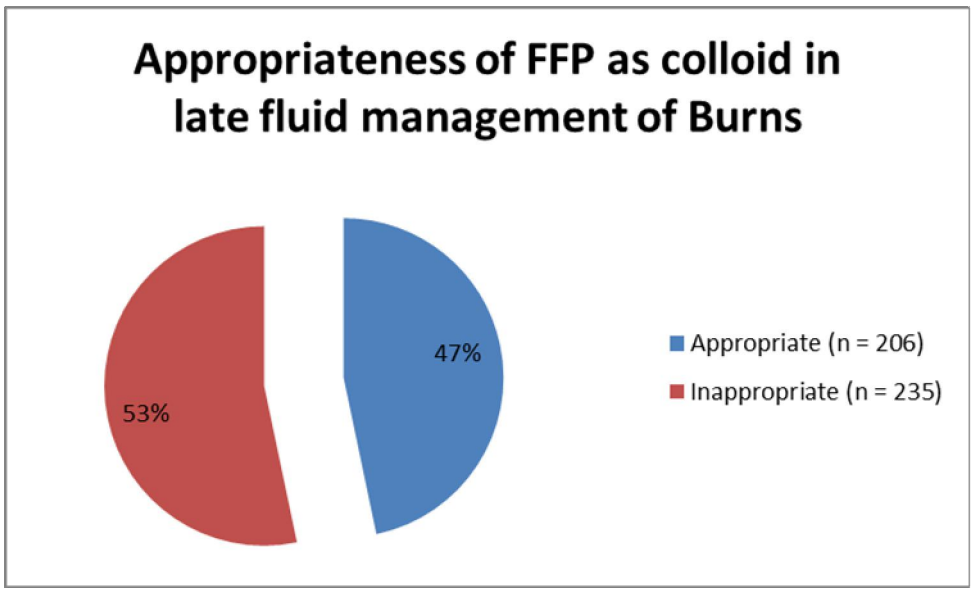


Fig 7: Appropriateness of FFP as colloid in treating burns

When following Baxter's original Parkland formula, in this study population (n = 122), no FFP was transfused in the initial 24 hours of burn injury. 206 units were transfused, at least, as double units (400 – 440 ml) in the second 24 hours after burn injury and were considered appropriate.

235 units of FFP transfusions were considered inappropriate.

The reasons for inappropriate transfusions were:

i) Inadequate doses (less than 0.5 mL/kg/% TBSA and as single doses). 100 units of FFP were transfused as single units.

ii) For treating hypoproteinemia

iii) To promote wound healing

7. Appropriateness of platelet transfusions:

In this study population (n = 122), only one of the Burns patient was transfused with one unit of random donor platelets. (An electrical burns patient undergoing amputation of both upper limbs up to elbow, for whom 4 units of red blood cells and 4 units of FFP were given followed by platelet transfusion, with a platelet count of 49,000/cu. mm.). All the burns patients had their platelet counts more than 10,000/cu.mm during their stay at hospital and all platelet transfusions can be considered appropriate.

Table 7: Mean and standard deviation of platelet count in burns patients:

Variable	Minimum	Maximum	Mean	Std. Deviation
Platelet count (in cells/cu.mm) (n = 122)	33000	660000	209762.30	106487.26

II. AGE OF RED CELLS AND LENGTH OF STAY (LOS):

Table 8: Difference in mean LOS between non transfused patients and transfused patients with variable storage age of RBCs:

Age of red cells – 7 days		
Variable	**LOS (in days)**	**P value**
Patients transfused with RBC units with < **7 days** storage(n = 33/122)	**29.6 (13.1)**	P < 0.05
Patients who have not received RBC units (n = 37/122)	13.19 (5.93)	
Age of red cells – 14 days		
Variable	**LOS (in days)**	**P value**
Patients transfused with RBC units with < **14 days** storage (n = 62/122)	**27.6 (12.1)**	P < 0.05
Patients who have not received RBC units (n = 37/122)	13.19 (5.93)	
Age of red cells – 21 days		
Variable	**LOS (in days)**	**P value**
Patients transfused with RBC units with < **21 days** storage (n = 46/122)	**27.47 (11.8)**	P < 0.05
Patients who have not received RBC units (n = 37/122)	13.19 (5.93)	
Age of red cells – any day of storage		
Variable	**LOS (in days)**	**P value**
Patients transfused with RBC units with **any age** of storage (n = 85/122)	**26.39 (11.91)**	P < 0.05
Patients who have not received RBC units (n = 37/122)	13.19 (5.93)	

In this study population (n = 122), the mean length of stay of transfused burns patient was longer than the non-transfused burns patient, irrespective of the storage age of red blood cells and it was statistically significant (P < 0.05).

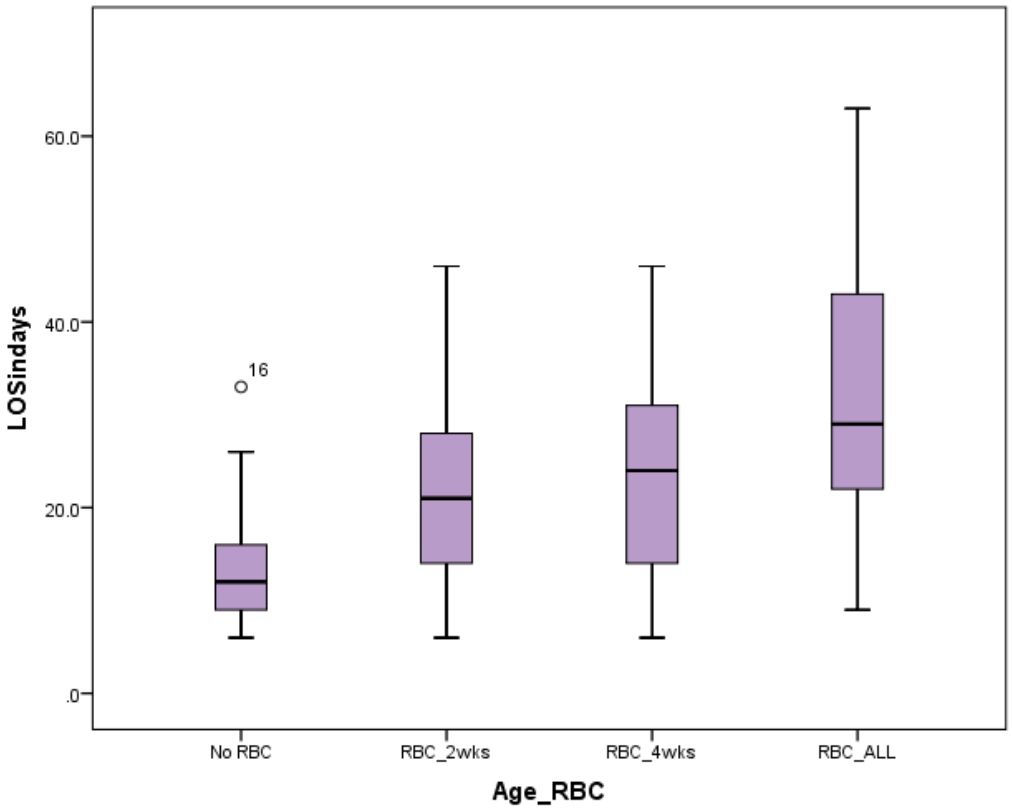


Fig 8: Difference in mean Length of stay between patients who did not receive RBCs (No RBC), RBCs of storage age < 14 days (RBC_2wks), RBCs of storage age >14 days (RBC_4wks) and patients who received RBC transfusions of any storage age (RBC_ ALL)

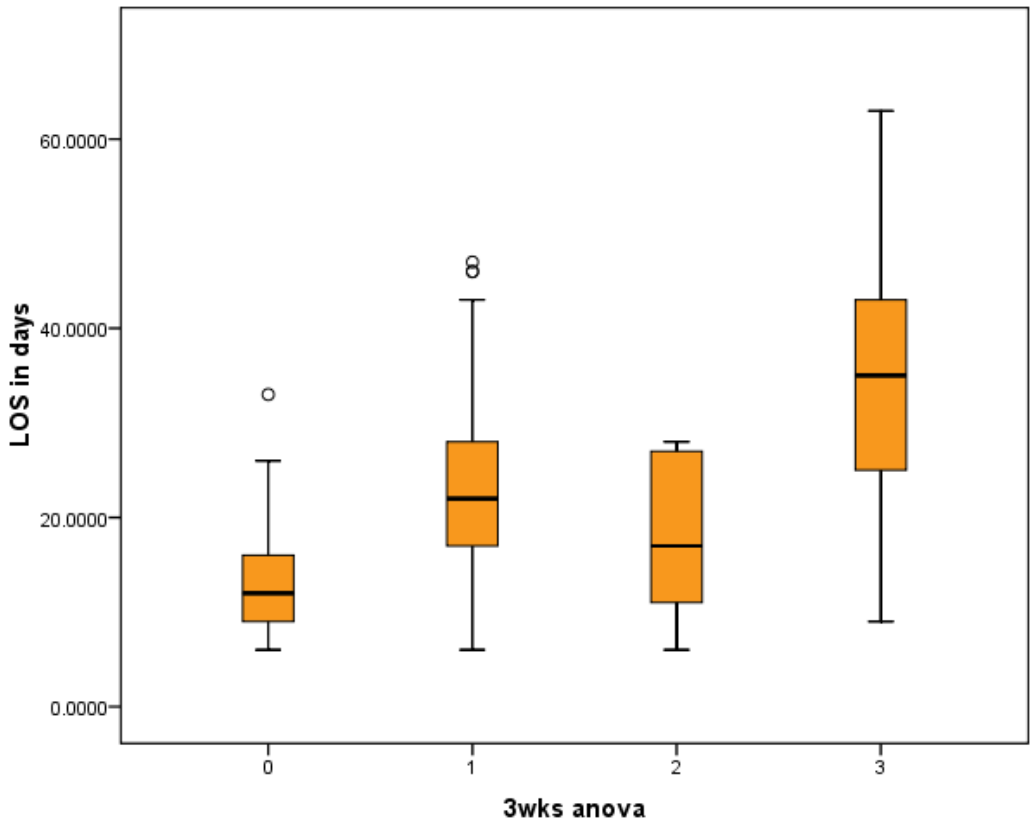


Fig 9: Difference in mean Length of stay between patients who did not receive RBCs (0), RBCs of storage age < 21 days (1), RBCs of storage age > 21 days (2) and patients who received RBC transfusions of any storage age (3).

Table 9: Difference in mean LOS in patients receiving RBCs of various storage ages:

Variable Age of red cells	Length of stay (in days) Mean (Std. Deviation)	P value
Patients receiving RBC **<14 days** of storage (n = 26/85)	22.03 (9.15)	> 0.05
Patients receiving RBC **>14 days** of storage (n = 37/85)	23.04 (10.89)	
Patients receiving RBC **< 21 days** of storage (n = 46/85)	24.09 (13.33)	> 0.05
Patients receiving RBC **> 21 days** of storage (n = 9/85)	25.33 (14.93)	

In this study population (n = 122), it was observed that the mean length of stay of burns patients receiving red blood cells stored for greater than 14 days and 21 days was not significantly longer than those receiving red blood cells stored for less than 14 days and 21 days respectively.

III. OTHER PARAMETERS INFLUENCING LENGTH OF STAY

1. Significance of correlating variables on Length of stay of Burns patients:

Table 10: Correlation values and their significance of variables affecting LOS:

Variable	Pearson Correlation value	P value
Total Body Surface Area burns vs. LOS	0.049	> 0.05
Age of Burns patient vs. LOS	0.102	> 0.05
APACHE II score vs. LOS	0.260	< 0.05
APACHE II risk score vs. LOS	0.288	< 0.05
APACHE II score vs. Blood transfusion	0.190	< 0.05
Total component transfusion vs. LOS	0.495	< 0.05
Total red cell transfusion vs. LOS	0.453	< 0.05

In this study population (n = 122), using Pearson correlation it was observed that the % TBSA and age of the Burns patient were not significantly correlated to length of stay while APACHE II score, APACHE II risk score, total component (whole blood, PRBC, FFP and PC units) transfusions and red blood cell (Whole blood and PRBC units) transfusions were positively correlated and statistically significant ($P < 0.05$).

2. APACHE II score and Length of stay:

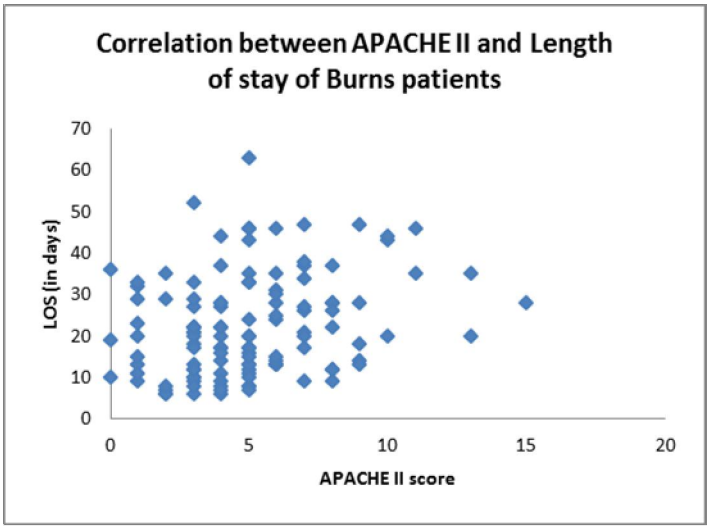


Fig 10: Correlation between APACHE II score and LOS

In this study population (n = 122), using Pearson correlation it was observed that APACHE II score of the Burns patient and length of stay were positively correlated (**r = 0.260**) and it was statistically significant ($P < 0.05$).

3. Total blood components transfused and Length of stay:

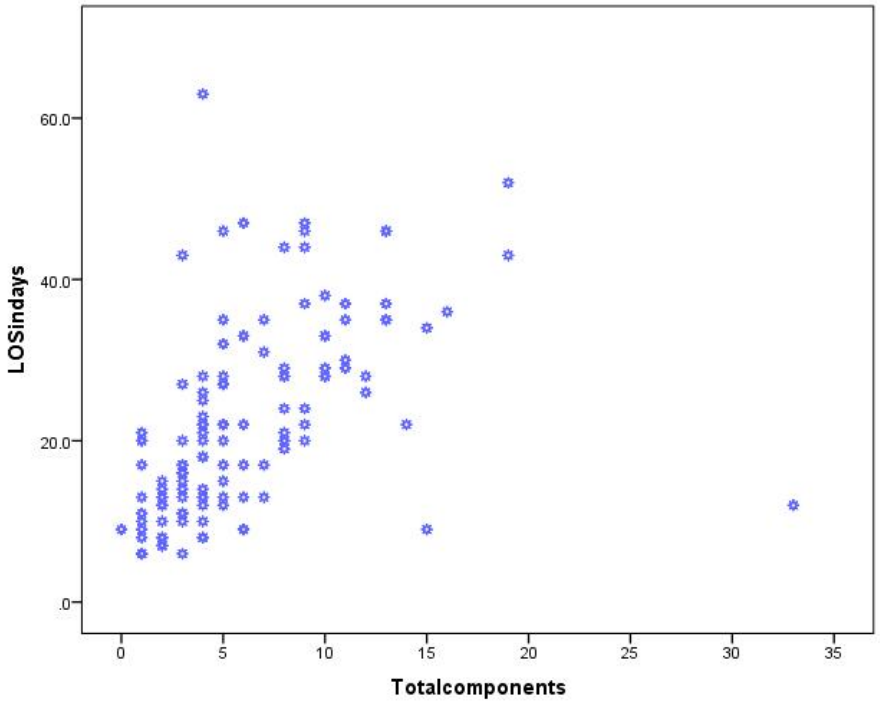


Fig 11: Correlation between blood component transfusions and LOS

In this study population (n = 122), using Pearson correlation it was observed that blood component transfusions in the Burns patient and length of stay were positively correlated (**r = 0.495**) and it was statistically significant ($P < 0.05$).

4. Red blood cell transfusions and Length of stay:

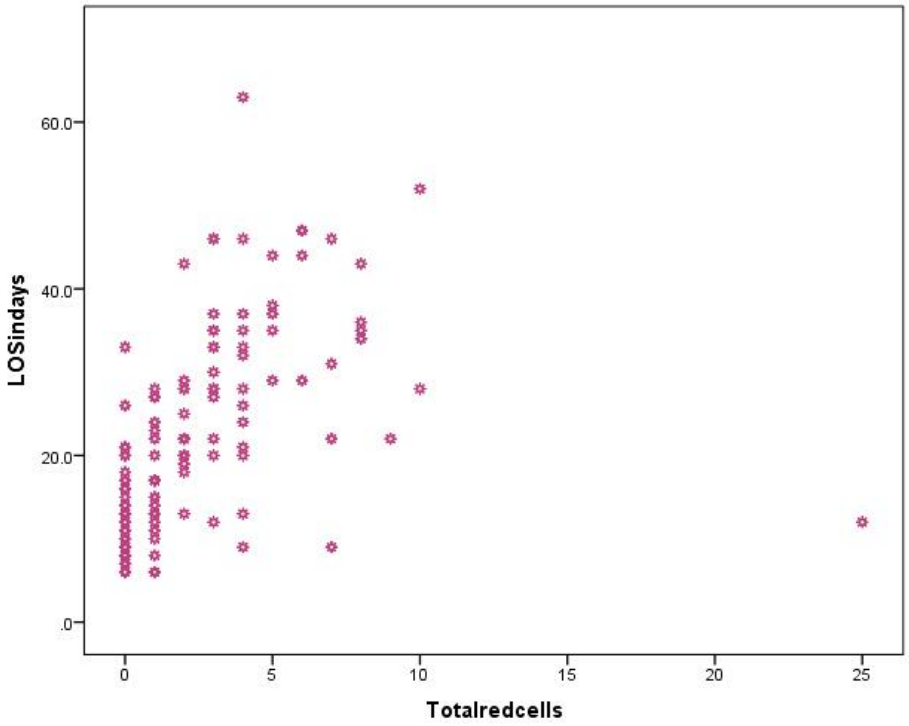


Fig 12: Correlation between RBC transfusions and LOS

In this study population (n = 122), using Pearson correlation it was observed that red blood cell (whole blood and packed cells) transfusions in the Burns patient and length of stay were positively correlated (**r = 0.453**) and it was statistically significant ($P < 0.05$).

5. Fresh frozen plasma transfusions and Length of stay:

Table 11: Difference in LOS in patients transfused/not transfused with FFP:

Variable **FFP transfusion**	**Length of stay** **(in days)** **Mean (Std. Deviation)**	**Pearson Correlation**
Transfused patients (n = 114/122)	22.03 (11.37)	0.422
Non transfused patients (n = 8/122)	**27.37 (20.13)**	

In this study population (n = 122), using Pearson correlation it was observed that fresh frozen plasma transfusions in the Burns patient and length of stay were positively correlated (**r = 0.422**) and it was statistically significant ($P < 0.05$). It was also observed that the mean length of stay for patients transfused with fresh frozen plasma was significantly shorter than those who were not transfused.

6. Wound infection in Burns patients:

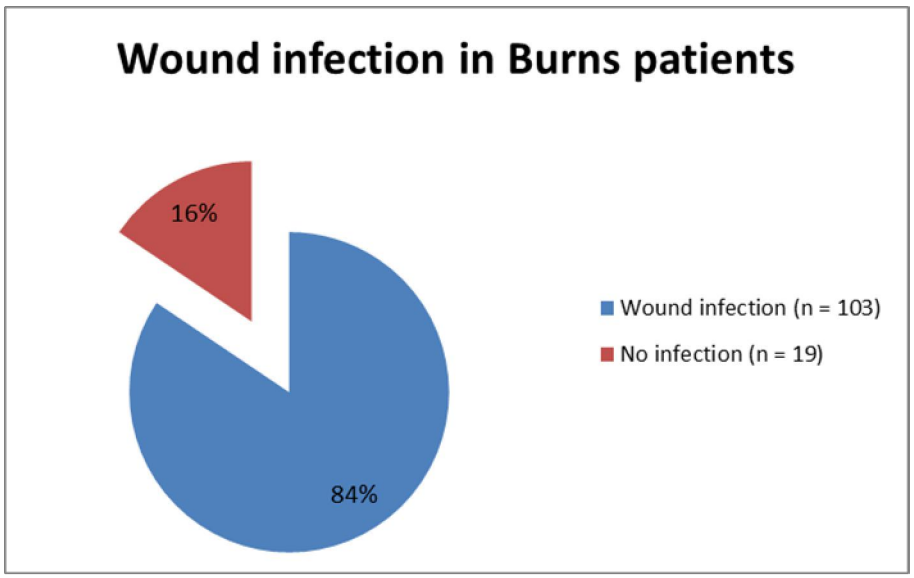


Fig 13: Percentage of burns patients with culture proven wound infections

In this study population (n = 122), culture proven wound infections were present in 103 patients.

7. Microbes causing wound infection in Burns less than 48 hours:

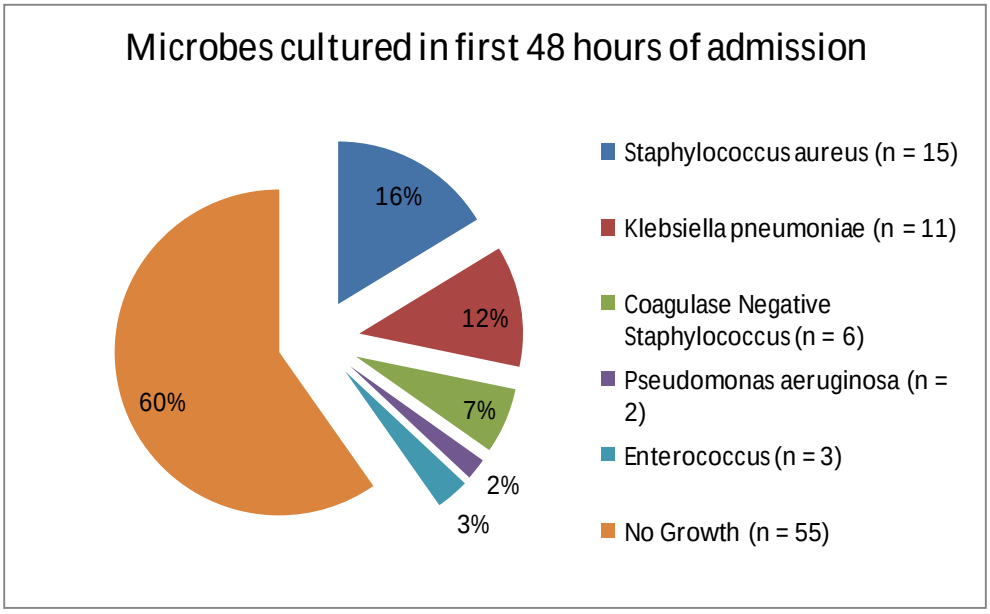


Fig 14: Microbes cultured in the first 48 hours of admission

8. Microbes causing wound infection in Burns from days 3 -7:

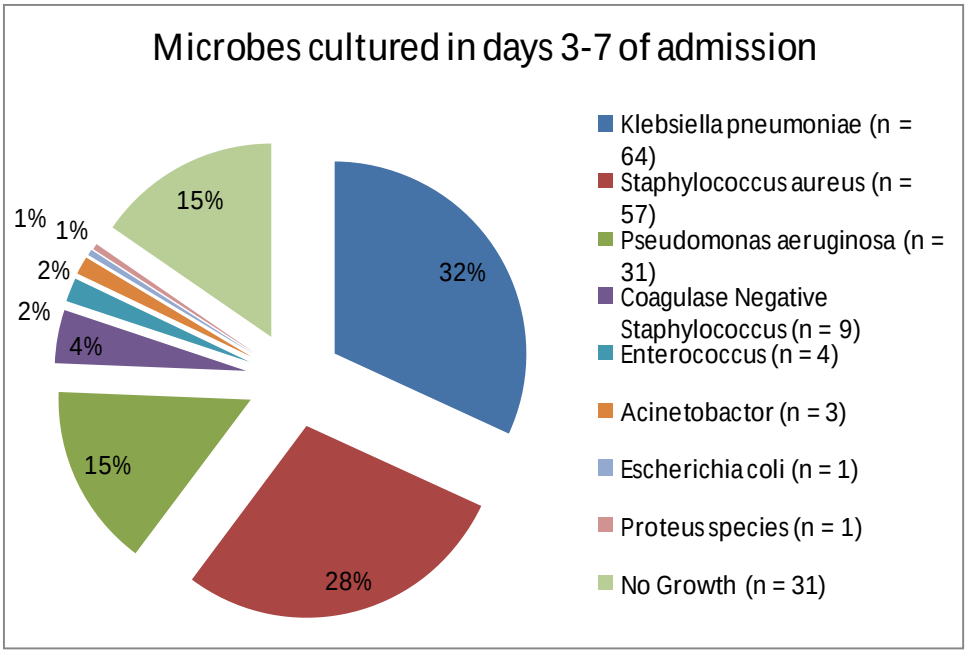


Fig 15: Microbes cultured in days 3-7 of admission

9. Microbes causing wound infection in Burns from days 8-14:

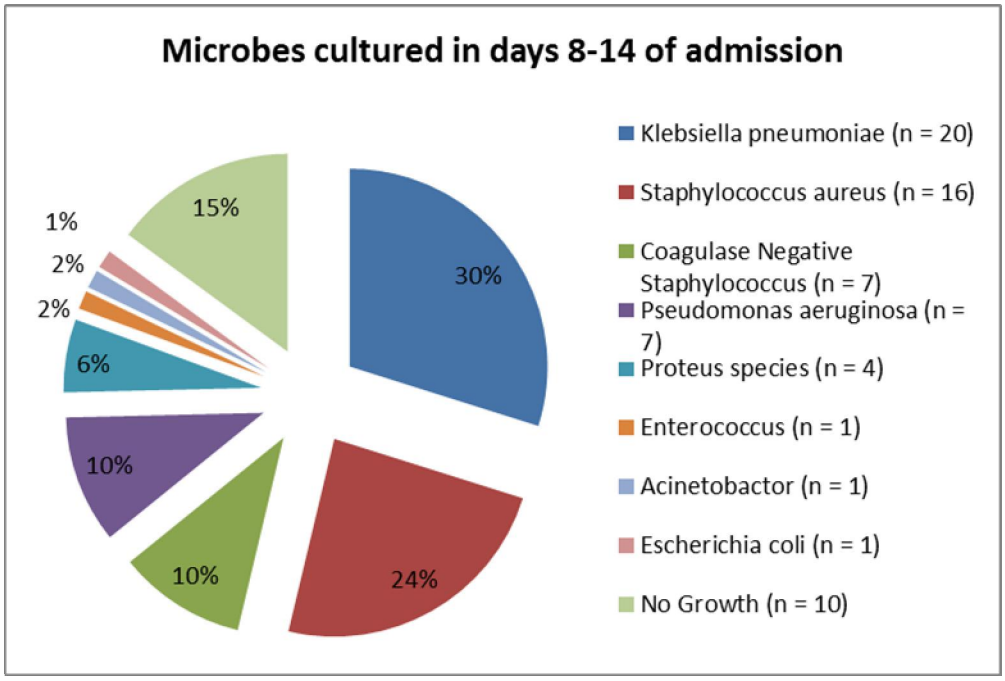


Fig 16: Microbes cultured in days 8-14 of admission

10. Microbes causing wound infection in Burns more than 14 days:

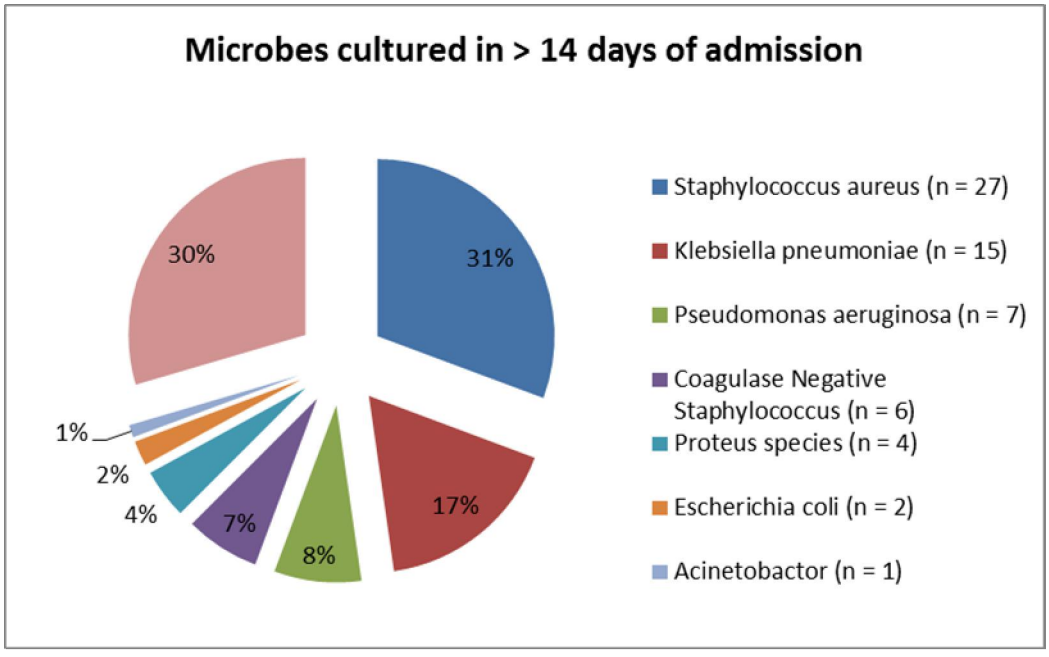


Fig 17: Microbes cultured > 14 days of admission

In this study population (n = 122), Staphylococcus species were the most common organisms cultured in the first week of admission. From second week of admission onwards, gram negative organisms (including Klebsiella species and Pseudomonas species) were cultured more frequently.

11. Wound infection and Length of stay:

Table 12: Difference in mean LOS in burns patients with/without wound infection

Variable **Wound infection**	**Length of stay (in days)** **Mean (Std. Deviation)**	**P value**
Burns patients **with** wound infection (n = 103/122)	**24.8 (11.5)**	P < 0.05
Burns patients without wound infection (n = 19/122)	9.3 (3.2)	

In this study population (n = 122), it was observed that the mean length of stay for burns patients with culture proven wound infection was significantly longer than those patients without wound infection.

12. Transfusions and wound infection in Burns patients:

Table 13: Difference in mean blood components transfused in patients with/without wound infection:

Variable	No. of units transfused [Mean (Std. Deviation)]	P value
Patients **with** wound infection and received transfusions (n = 102)	**6.31 (4.9)**	0.03
Patients **without** wound infection and received transfusions (n = 19)	2.74 (1.6)	
Patients **with** wound infection and received whole blood transfusions (n = 70)	**3.10 (2.4)**	0.03
Patients **without** wound infection and received whole blood transfusions (n = 6)	1.00 (0.0)	
Patients **with** wound infection and received PRBC transfusions (n = 39)	2.08 (1.47)	> 0.05
Patients **without** wound infection and received PRBC transfusions (n = 2)	2.00 (1.41)	
Patients **with** wound infection and received FFP transfusions (n = 94)	**4.03 (2.33)**	0.01
Patients **without** wound infection and received FFP transfusions (n = 18)	2.33 (1.14)	

In this study population (n = 122), among patients who were transfused during their stay in the Burns ward (n = 121), those with culture proven wound infections (n = 102) had received more blood component transfusions (total components, whole blood and fresh frozen plasma) than those without wound infection (P < 0.05). There was no significant increased use of packed red blood cell units in burn patients with wound infection compared to those without wound infection.

13. Wound infection in transfused burns patients and Length of stay:

Table 14: Difference in mean LOS in transfused burns patients with/without wound infection

RBC Transfusion status	**Variable Wound infection**	**Length of stay (in days) Mean (Std. Deviation)**	**P value**
Transfused with Red blood cells (n = 85/122)	Burns patients **with** wound infection (n = 78/85)	**27.76 (11.9)**	P < 0.05
	Burns patients without wound infection (n = 7/85)	11.14 (4.37)	
Not transfused with Red blood cells (n = 37/122)	Burns patients **with** wound infection (n = 25/37)	15.6 (5.73)	P < 0.05
	Burns patients without wound infection (n = 12/37)	8.17 (1.59)	

In this study population (n = 122), it was observed that the mean length of stay for burns patients with culture proven wound infection who had received RBC transfusions was significantly longer than those patients who did not receive RBC transfusions.

14. Surgical procedures performed in Burns patients:

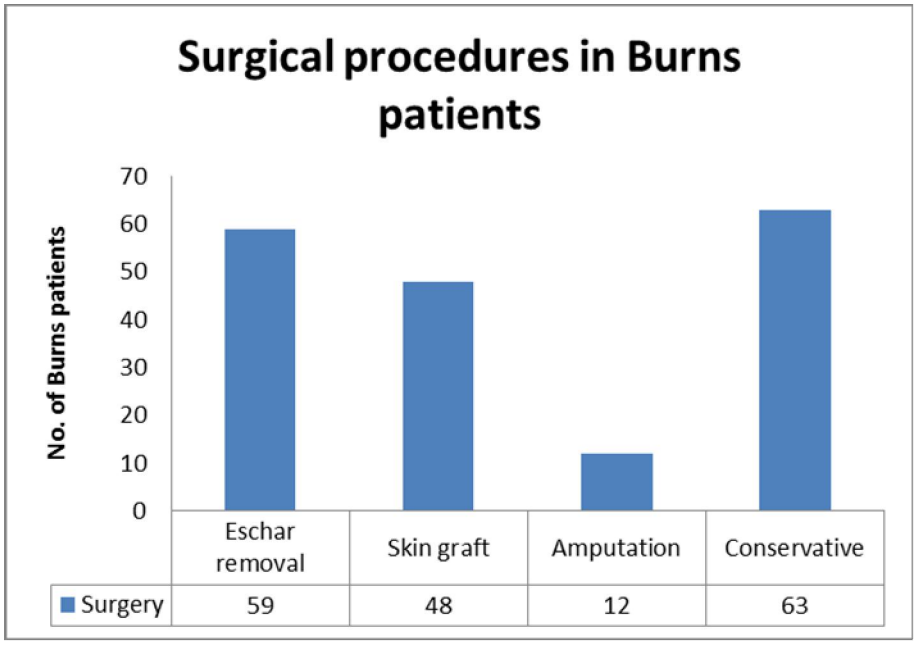


Fig 18: Surgical procedures performed in burns patients

28 patients had both Eschar removal and split skin grafting, while 6 patients had all three procedures viz. eschar removal, skin grafting and amputation.

15. Surgical procedures and Length of stay:

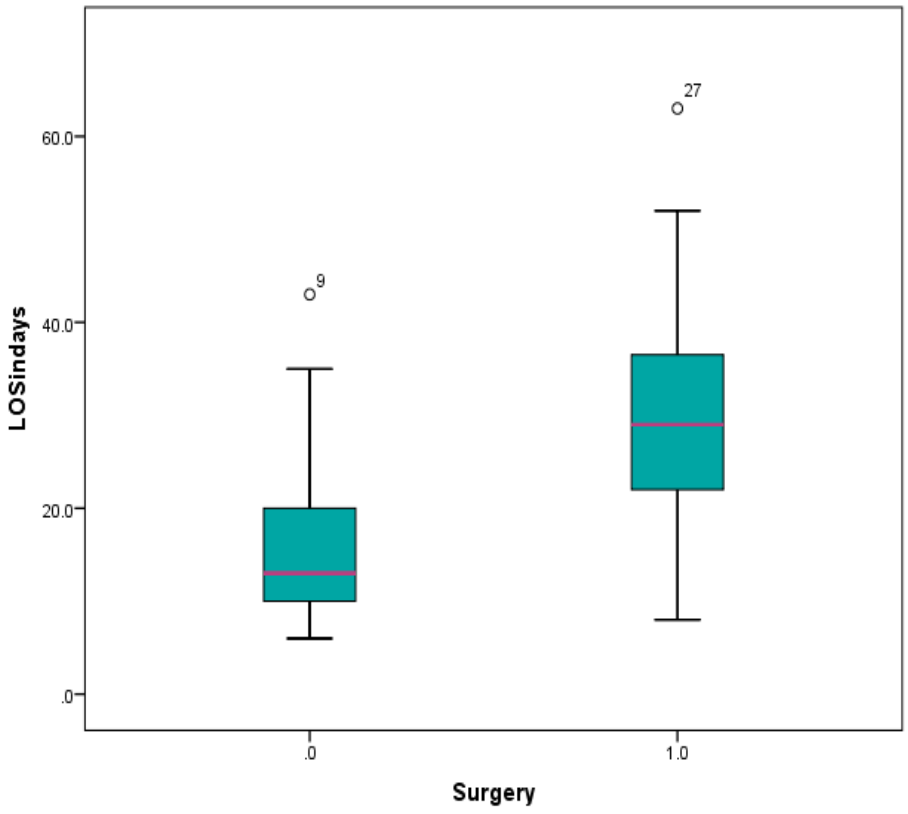


Fig 19: Difference in mean LOS in patients undergoing surgery and treated conservatively

In this study population (n = 122), it was observed that the mean length of stay for burns patients undergoing surgical procedures was longer than those patients treated conservatively.

Table 15: Difference in mean LOS in RBC transfused patients undergoing surgery and treated conservatively

RBC Transfusion status	**Variable Surgical procedures**	**Length of stay (in days) Mean (Std. Deviation)**	**P value**
Transfused with Red blood cells (n = 85/122)	Patients undergoing **surgery** (n = 54/85)	**31.15 (10.99)**	P < 0.05
	Patients treated **conservatively** (n = 31/85)	18.09 (8.45)	
Not transfused with Red blood cells (n=37/122)	Patients undergoing **surgery** (n = 5/37)	17.8 (11.12)	P < 0.05
	Patients treated **conservatively** (n = 32/37)	12.47 (4.57)	

In this study population (n = 122), it was observed that the mean length of stay for burns patients who underwent surgical procedures and received RBC transfusions was longer than those patients treated conservatively or with no RBC transfusions.

DISCUSSIONS

I. PATIENT CLINICAL DETAILS:

1. Age of the Burns patient:

The mean age of Burns patients in the present study (35.38 ± 12.93) was similar to study by Gupta *et al.*[14] (19.6) but studies by Hashmi *et al*.[50] (22) and Bain *et al.* [62] (26) showed a lesser mean age while Lu *et al.* [22] (48.3) showed a higher mean age of burns patients.

2. Sex of the Burns patient:

Male predominance in Burns (54%) seen in the present study was similar to studies by Hashmi *et al.* [50] (57.8%) and Gupta *et al.* [14] (54%) but other studies by Bain *et al.* [62] (66.8%) and Chakraborty *et al.* [61] (61.5%) showed burns to be more common in females.

3. Cause of Burns:

Thermal burns was more common in the present study (74%) which was similar to other studies by Bain *et al.* [62] (80%) Gupta *et al.* [14] (72%) who showed the predominance of thermal burns, but study by Tyson *et al.*[17] (52%) showed that scalds were the commoner cause of burns.

4. Hemoglobin level at admission:

The hemoglobin level of the Burns patients at admission in the present study (n = 122) was 12.53 gm/dL (SD - 2.49). A study by Vincent *et al.*[79] (n = 1136) showed lower hemoglobin level of 11.3 gm/dL (SD – 2.3) in Burns patients during admission.

II. APPROPRIATENESS OF BLOOD COMPONENT UTILIZATION:

1. Appropriateness of Red blood cell transfusions:

In the present study, 85 patients were transfused with 308 red cell units of which nearly 50% of the burns patients (n = 43) were transfused with a hemoglobin level below 10 gm/dL. The mean pretransfusion hemoglobin level was 9.67 gm/dL for all transfused patients. This was higher than the mean pre-transfusion hemoglobin level of 8.4 gm/dL in the study by Vincent *et al.* [79] but even in their study, pre-transfusion hemoglobin level was greater than 9 gm/dL in more than 30 % of the ICU patients.

The mean blood units transfused in Burns patients in this present study (3.41 units) was comparable to other studies by Vincent *et al.* [79] (4.8 units) and Lu *et al.* [22] (6 units). But other studies by Posluzny *et al.* [5] (16.6 units), Palmieri *et al.* [39] (13.7 units) and Gupta *et al.* [14] (8 units) showed a higher mean number of blood units transfused.

Most of the red cells transfused in burns patients in this present study belonged to second and third week of storage, which was similar to mean storage age of 16.2 days in the study by Vincent *et al.* [79] and 16-21 days by Aubron *et al.*[47]

The patient profiles in the present study had varied, from a patient who was conservatively managed without any blood component transfusion to an electrical burns patient, who was transfused with 25 units of red cells, 7 units of fresh frozen plasma and 1 unit of platelets and underwent 4 surgical procedures.

Use of blood components when are they are not necessary, for example patients with minor or partial thickness burns, who can be managed with only fluids, constitutes inappropriateness. As literatures suggest, burns up to 25% TBSA can be managed with only fluids (oral/intravenous) unless the precarious condition of the burns patient warrants transfusions.[24, 27, 28, 29] This is true especially in patients with electrical burns who may need amputation to save limb or life, and transfusions are inevitable. Burns patients can have a fall in haemoglobin levels not only during surgical procedures but also later due to anemia of critical illness.

Hemoglobin levels in burns can be spuriously high, due to the profound fluid loss leading to hemoconcentration, which may mask the underlying anemia. Adequate hydration will show the true picture, at which time the anemia can lead to complications.

Various studies have shown the efficacy of restricted hemoglobin triggers (Hb between 7-9 gm/dL and maintaining hemoglobin of 8-10 gm/dL) when compared to liberal transfusion triggers (Hb around 10 gm/dL and maintaining hemoglobin levels between 10-12 gm/dL) in critically ill patients. Patients are usually transfused with single red cell units with frequent monitoring in-between transfusions.

According to recommendations, when a hemoglobin trigger of 10 gm/dL is applied, 64% of all red cell transfusions can be considered appropriate.

The reasons for the inappropriate red cell transfusions included, blood loss during surgical procedures, bleeding burns patients and other co-morbid conditions like ischemic heart disease and diabetes mellitus. In the present study, 47 red blood cell units were transfused to burns patients with a hemoglobin level greater than 10 gm/dL, during surgical procedures.

The reasons for red blood cell transfusion in burns patients with hemoglobin level of 10 gm/dL included: the patient's anemia masked by hemoconcentration, surgeon's helplessness in estimating the rate and amount of bleeding during burns surgery and the anesthetist's reluctance to wait till Hb reaches below 8 gm/dL.

French *et al*.[54] in their study with hemoglobin trigger of 10 gm/dL found only 3% inappropriate transfusions whereas Afzal *et al*.[55] in his study in patients with hemoglobin less than 10 gm/dL, found 54.1% appropriate transfusions.

In the present study, most of the red blood cell transfusions were whole blood (n = 223). Whole blood is transfused in the belief that it will provide all components of blood and thus will aid in wound healing. As the present study shows, the mean hospital length of stay was not significantly shorter for patients transfused with whole blood, when compared to those patients who were transfused with PRBC. So, the use of whole blood should be curbed with rational use of blood as components.

2. Fluid management in burns patients and role of Fresh frozen plasma:

Till the 1950s, burns involving even 10 – 20 % TBSA were associated with high mortality. It was then the importance of fluid management in burns was understood and the first fluid resuscitation protocol was given by Evans in 1952. After many trials in the 1960s, Charles Baxter gave the widely acclaimed Parkland formula (1974) for fluid resuscitation in burns patients. This formula holds good even today, and is followed all over the world with minor modifications.[33]

The original Parkland formula had incorporated fluid management with only crystalloids during the initial 24 hours after burn injury and management with colloids (Fresh frozen plasma) during the second 24 hours after burns. When a consensus was explored, the initial 24 hours fluid resuscitation with crystalloids was accepted but the next 24 hour resuscitation with colloids was not considered. But fresh frozen plasma was still used in burn resuscitation as a colloid till the end of 1980s when the HIV epidemic shook the world with a high risk of transmission by transfusion. So, rational use of blood and blood products was advocated and use of FFP for volume resuscitation was held inappropriate.[34]

When alternatives to FFP were searched, 5% albumin, dextran and hydroxyethyl starch were introduced with much promise. 5% Human albumin is the most commonly advocated and used colloid for late fluid management in burns. It is iso-oncotic and has a half-life of about 20 days. [84] Even though effective in hypovolemia and hypoproteinemia (25%), the multiple indications

for which Human albumin was supposed to be helpful have been questioned in recent trials and observations. The recent meta-analysis by Cochrane review group had found that use of albumin had not reduced mortality when compared to crystalloids but rather suggested an increased risk of mortality in burns patients. These effects were attributed to the prolonged heat treatment of albumin (10 hours at 60 ^{0}C) which made the molecules more permeable with loss of electronegative charge. Thus albumin inhibits platelet aggregation and enhances inhibition of factor Xa by Anti-Thrombin III.[31]

In India, the price of 20% human albumin was 4904 rupees. But ever since the Indian Drug Price Control Order (DPCO) 2013 by National Pharmaceutical Pricing Authority (NPPA) brought it under essential drug list, there has been a shortage for human albumin solutions.[35]

Dextrans were helpful in hypovolemia by having a long intravascular half life but had significant adverse effects like anaphylaxis, pulmonary edema, platelet disorders and acute renal insufficiency.

Hydroxylethyl starch showed much promise in hypovolemia but the FDA had issued a black box warning in 2013 restricting its use in critically ill with sepsis with a risk of acute renal insufficiency. There is also an increased risk of bleeding as patients transfused with dextran showed a 50% fall in factor VIII levels.[36]

In such a scenario, the limited availability of albumin and its prohibitive cost has made the clinicians turn back to fresh frozen plasma as a colloid. FFP contains 0.025 g of albumin/mL, [84] while 5% albumin contains 0.05 g of

albumin/ mL. The adequate dosage of FFP is 0.5 ml/kg/% TBSA, which is necessary to derive the desired effects of FFP as a colloid. In the present study, FFP was mostly given as two units prepared from 350 ml of whole blood (total dose of 400-450 ml) which was equivalent to a dose of 200 ml of 5% albumin.

The dose of plasma to increase albumin by 0.5 g/dL is approximately 20–30 mL/kg/day, assuming no extraordinary loss or metabolism.[84] This necessitates a large volume of plasma to be transfused especially in burns patients, who are already in a hypermetabolic state. Thus FFP is not suitable for treating hypoalbuminemia.

Fresh frozen plasma contains not only albumin (albeit in smaller amounts) but other procoagulant factors like fibrinogen, anti-proteases and also fibronectin which gives it an added advantage. But FFP has its own demerits in risk of transfusion transmitted infections and transfusion related immunomodulation. Sarani *et al*.[83], in their study involving 2267 ICU patients, have found that infectious episodes were more common in those transfused with fresh frozen plasma when compared to non-transfused patients.

FFP replenishes fibrinogen and other coagulant factors in burns patients. It also contains fibronectin, shown to be decreased in burns patients, which has opsonic activity and reinforces leukocyte activity in burns. Fibronectin in FFP transfused to burns patients has been shown to decrease incidence of sepsis for about 24 hours after transfusion.[85]

If the FFP appropriate transfusion guidelines are applied, all the transfusions used for burns as in the present study would seem inappropriate.

But on applying the Baxter's original Parkland formula for late fluid resuscitation in burns which uses FFP as the colloid, we found 47% of the transfusions to be appropriate. This is similar to the 52% inappropriate FFP transfusion results obtained by Kulkarni *et al.* in 945 patients with 1884 FFP transfusions. [56] The reasons for inappropriate transfusions were high cost and unavailability of 5% albumin, use for hypoproteinemia and to aid wound healing.

The risk of TTI can be reduced by stringent donor selection, advanced screening technologies like Nucleic Acid Testing, pathogen reduction technology; risk of TRALI can be reduced by preparing FFP from predominantly male donors and nulliparous female donors;[51] and risk of TRIM can be reduced by leukofiltration. If risks are minimized, fresh frozen plasma can be more beneficial than detrimental in burns management as shown by Fodor *et al.*[28]

In the present study, the mean length of stay was significantly shorter for patients transfused with fresh frozen plasma when compared to those patients who were not transfused with FFP. This result is in contrast to the study by Sarani *et al.* [83], which showed that the LOS was prolonged in critically ill patients who were transfused with FFP. This finding should not be interpreted that FFP was beneficial for burns in this study but rather it signifies the beneficial effect of colloids in the late fluid management of burns. One other reason was that even though the patients had not received FFP, they had received RBC units and underwent surgery. This may have prolonged the mean LOS of the patients who were not transfused with FFP.

Thus, in managing 15 – 40% burns crystalloids are the mainstay of treatment. Colloids are used only when crystalloids are inadequate in maintaining fluid volume or when complicated by fluid creep.

In a resource limited country like India, use of FFP as a colloid replacement is still indispensable, until other colloids (5% albumin or HES) become freely available in market at an affordable cost. Even then, colloids are advised only when the benefits outweigh risks.

3. Appropriateness of platelet transfusions:

It is well known fact that thrombocytopenia is encountered in the first week of burns injury but it reaches normal levels in the second week. Hence platelet transfusions are usually not indicated for the initial fall in platelet counts. Gajbhiye *et al*.[65] in their study on 594 burns patients, have found that serial decline in platelet count was a bad prognostic indicator of septicemia in Burns patients. Such patients need, in addition to treatment like hydration and antibiotics, blood transfusions. Platelet transfusions are not usually indicated in surgical patients till the platelet count falls below 50,000/cu.mm of blood.[51] In the present study, only one patient was transfused with one unit of platelets during limb amputation surgery for electrical burns along with 4 units of RBCs and 4 units of FFP (with a platelet count of 49,000/cu. mm). The minimum platelet count encountered in this present study was 33,000/cu. mm. for which no platelet transfusion was given. Hence all transfusions regarding platelet requirements can be considered appropriate. Schofield *et al*.[59] showed a 67% appropriate platelet transfusions in 1147 patients from 14 public hospitals in New South Wales.

III. PARAMETERS INFLUENCING LENGTH OF STAY:

With better accessibility to tertiary care with Emergency Medical Services (EMS) vehicles and long strides in Burns injury care, more Burns victims are surviving and so quality of life parameters are taking prominence over mortality parameters. Length of hospitalization is one of the easily monitored and accessible parameters, which gives a better view on burns care and patient survival. But length of hospital stay is influenced by multiple factors from patient demographics to transfusion, surgery and sepsis. When multivariate analysis is undertaken, exclusion of non-survivors from analysis can help identify prognostic factors for hospital Length of stay.[85] Thus, this study includes only patients who are discharged from hospital after treatment.

1. Length of stay:

The mean length of stay of Burns patients in the present study (n = 122) was 22.39 with a minimum and maximum stay of 6 days and 63 days. The study by Gupta *et al.*[14] showed a higher mean length of stay of 57 days while Bain *et al.*[62] showed a lower mean length of stay.

2. Age of the Burns patient:

In the present study, even though age of the Burns patient was positively correlated to hospital length of stay, it was not statistically significant. This is similar to the result obtained by Posluzny *et al.*[5] who did not find correlation between age and LOS but in contrast to the studies by Edgar *et al.*[63] and Hussain *et al.*[85] whose studies showed that advancing age was a significant factor for prolongation of hospital length of stay.

3. Total Burnt Surface Area:

In the present study, total burnt surface area (TBSA) was taken as 15-40% because, below 15% TBSA burns, hospitalizations are rarely necessary and in burns above 40%, mortality risk is higher.[8,20] Hussain *et al.*[85], in their review have shown that % TBSA is a better predictor of hospital LOS. As the present study results show, the restricted TBSA of 15-40% was not significantly correlated to length of stay and hence the confounding factor of TBSA burns was overcome and the significance of other factors became absolute.

4. APACHE II score:

APACHE II score which was developed as a mortality predictor also doubles up as a morbidity predictor. As the % TBSA has been restricted in the present study, the APACHE II score obtained was low (maximum score 15). Still APACHE II score and the APACHE II risk score showed a positive correlation to length of stay which was statistically significant.

5. Blood component transfusions:

In the present study, it was observed that as the number of blood transfusions increase in the burns patient, there was a significant prolongation of hospital length of stay. The results were similar to those obtained by Neamtu *et al.*[41], Palmieri *et al.*[39], Malone *et al.* [80], Vincent *et al.*[79] and Roubinian *et al.* [53]

Burns patients receiving blood transfusions showed a significant positive correlation to APACHE II score at admission, which was similar to the studies by Posluzny *et al.* [5] and Vincent *et al.* [79] who showed that transfused patients had higher APACHE II scores.

6. Storage age of Red Blood Cells:

Many observational studies and clinical trials have tried to prove the deleterious effects of increasing storage age of red cells but none have given conclusive results. While Pettila *et al.* [44] showed increased mortality in the critically ill patients transfused with older red blood cells; AABB technical manual and the Cochrane review 2015 have not found any clear differences in clinical outcomes between fresher and older red blood cells. [45, 46] The present study also did not find any significant prolongation of mean hospital length of stay among two groups (receiving initial 14 days stored RBCs vs. more than 14 days stored RBCs, receiving initial 21 days stored RBCs vs. more than 21 days stored RBCs). But there was significant prolongation of mean hospital length of stay in transfused burns patients when compared to non-transfused burns patients, irrespective of storage age of red cells.

7. Wound infection:

In the present study, 103 burn patients had culture positive wound infections of which Staphylococcus species were the most common organism cultured in the first week of admission. From second week of admission onwards, gram negative organisms including Klebsiella species and Pseudomonas species were cultured more frequently. These results are similar to the other studies by Church *et al.*[6] and Khaliq *et al.*[12] who showed gram positive organisms in the first 48 hours by colonization from skin flora and gram negative organisms after 5-7 days of burn injury by colonization from enteral flora.

In the present study, wound infection in Burns patients was significantly associated with prolonged stay in hospital which was in contrast with study by Khaliq *et al.* [12] who reported that colonization of wounds by micro-organisms were not culprits in prolongation of hospital stay. In the review article on burn wound infections, Church *et al.* [6] emphasizes that multi drug resistant microbes increase length of hospitalization.

8. Influence of transfusion on wound infection:

In the present study, burns patients with culture proven wound infections had received more blood components than those without wound infection. These results were similar to the study results from Palmieri *et al.*[39] who showed that blood transfusion increased the risk of infection by 13% per unit transfused. Also, Lelubre *et al.*[1] in his review has identified RBC transfusion as an independent predictor of infections in the critically ill patients.

The increased susceptibility for wound infections can be explained by the immunomodulation normally seen after acute burn injury which is compounded by transfusion related immunomodulation (TRIM). The normal host defense response is suppressed by an increasing concentration of suppressive interleukins like IL-4, IL-10 and PGE2.[5] This has dual responses, one of which is better skin graft uptake and the other is susceptibility to microbial invasion. Even though immunosuppression after burn injury is ubiquitous, blood transfusion further compromises the immune system, increasing the susceptibility to microbial infection and affecting mortality and morbidity. [39]

9. Surgical Procedures:

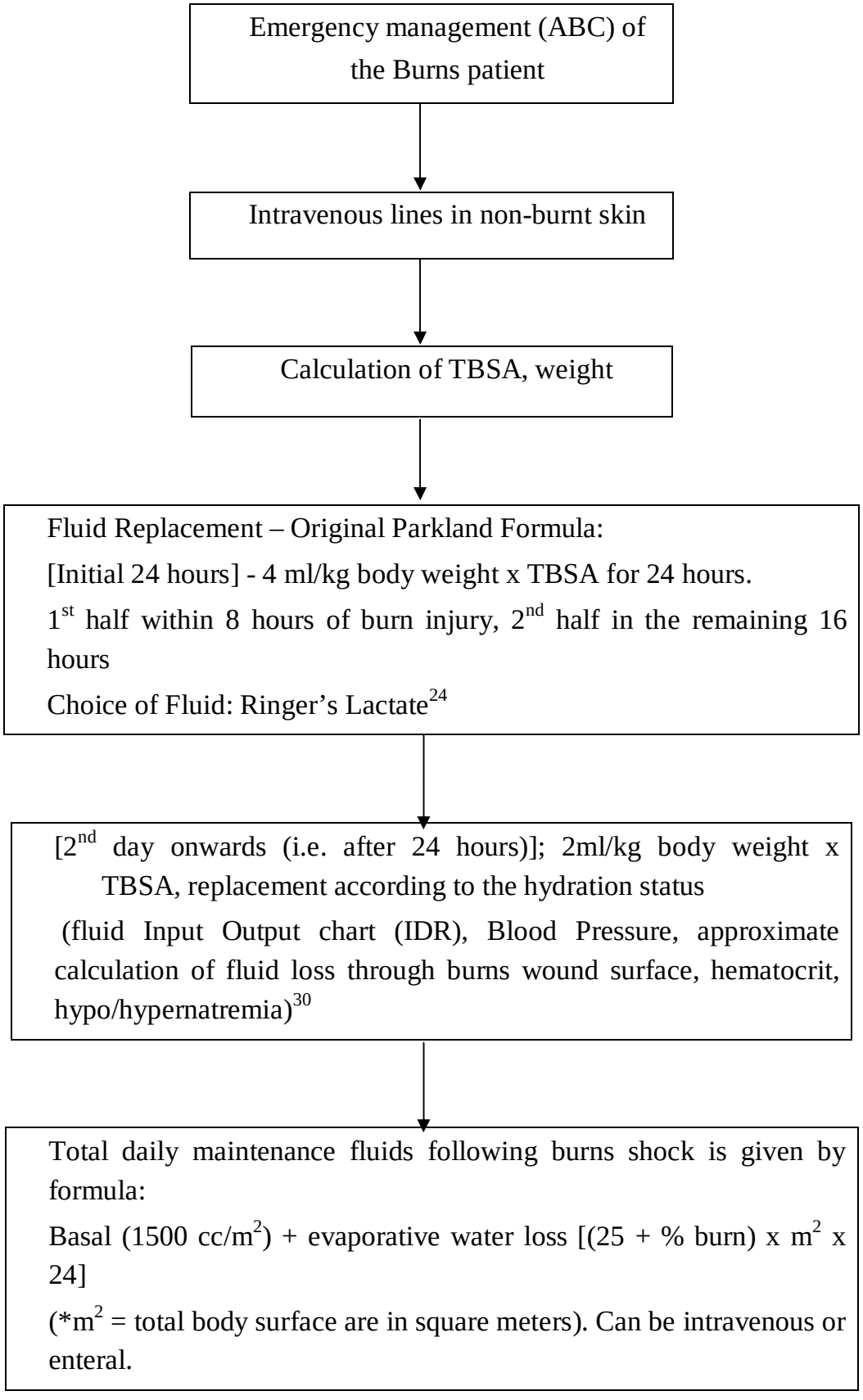
In the present study, 59 patients underwent 119 surgical procedures of which the commonest surgery was eschar removal 32% (n = 59). Next common surgery was split skin grafting 26% (n = 48). These were similar to the results obtained in the study by Palmieri *et al.* [39] who showed that eschar removal was the common surgery in 30% of burn patients. But results from Gupta *et al.* [14] study showed that split skin grafting (46.6%) was the most common surgery followed by eschar removal (36.5%).

In the present study, patients who underwent surgical procedures received more blood transfusions than those treated conservatively. These results were similar to the findings by Posluzny *et al.* [5] who showed that transfusions were significantly correlated with number of operative procedures.

In the present study, Burns patients undergoing surgical procedures had a significantly prolonged length of hospital stay when compared to those patients treated conservatively. These results were similar to those obtained in the study by Hussain *et al.* [85] and Gupta *et al.* [14]. Gupta *et al.* study showed that while Burns patients treated conservatively had a mean length of stay of 24 days (±18), patients treated with surgical procedures had a mean length of stay of 62 days (±26).

Thus, the factors significantly increasing length of stay (and thus wound healing) of burns patients in the present study include APACHE II score at admission, RBC transfusions, surgical procedures and wound infections. The factors not found to significantly influence length of stay (and thus wound healing) were age of the burns patient, sex, and storage age of red blood cells.

FLUID MANAGEMENT IN BURNS - ALGORITHM



Intake Diuresis Ratio (IDR) - [based on fluid intake (intravenous and oral), urine output, transdermal fluid loss, insensible fluid loss]

(The transdermal fluid loss - calculated as 40 ml/% TBSA/day)[30]

Use of Colloid in burns Patients

Colloid administration should be considered only after 24 hours of burn (24hrs post-burn). When urine output is maintained between 30-50 ml/ hr (or 1ml/kg/hr) for 2 hours, reduce crystalloids (RL) dose by 10%, to avoid fluid creep. [24]

Be vigilant about excess urine output i.e. more than 1ml/kg/hr which might lead to fluid creep and compartmental syndrome (mainly Abdominal Compartment Syndrome), eventually leading to death. However, there are studies which support careful usage of colloids in the following situations: [24]

i. Patients with burns of more than 20% TBSA are definitely at risk for developing burns shock. In burns involving more than 25% TBSA, capillary permeability is increased both in burnt and non-burnt areas leading to fluid creep. This is likely to result in resuscitation morbidity (anasarca/ orbital compartmental syndrome/ extremity compartmental syndrome/ abdominal compartment syndrome/ pulmonary edema, pneumonia/ septicemia/ ARDS/ multiorgan failure or death)

ii. Colloid, whether given as plasma, albumin or hetastarch is significantly more expensive than crystalloids.

Fresh Frozen plasma is probably the best colloid solution available for acute burn resuscitation, [28] particularly whenever there is a serious coagulopathy risk

Indications for colloids in resuscitating Burns patients:

Patients requiring more fluid volumes than predicted by the parkland formula [(i.e. > 4ml/kg x TBSA/day) may get a third of their hourly fluid volumes as colloids (5% albumin) [24]/ hetastarch/ Fresh Frozen Plasma]

Projected 24 hr resuscitation exceed 6ml/kg/hr near the 12 hr mark

Resuscitation volume more than 237 ml/kg over 12hrs (16 lts during a 12 hr period in 70 kg man) appears to be the threshold for the development of ACS.

SUMMARY

In our study,

I. On appropriate use of blood components

- 122 Patients who were admitted to the Department of Burns, Plastic and Reconstructive Surgery, Kilpauk Medical College with 15 – 40% burns were followed for a period of one year from September 2014 to August 2015.
- Mean age of the study group was 35 years and 54% were males
- The most common cause of burns was thermal burns (74%).
- Mean Hemoglobin level at admission was 12.53 gm/dL.
- 121 out of 122 patients had received atleast one blood component.
- 85 patients had received red blood cell transfusions. A total of 308 red blood units were utilized. Out of these 308 units, 167 belonged to second and third week of storage.
- The mean pre-transfusion hemoglobin level was 9.67 gm/dL. A mean of 3.41 red blood cell units were utilized in transfused burns patient.
- While following New York State Council guidelines for transfusion of RBCs in Burns 2012, when a hemoglobin trigger of 10 gm/dL was applied, 64% of red blood cell transfusions (n = 198) were considered appropriate.

- 223 units of whole blood were utilized in this study population.
- When following Baxter's original Parkland formula for fluid management in Burns, 47% of all FFP transfusions (n = 206) were considered appropriate. Of the 235 inappropriate FFP transfusions, 100 were of single unit transfusion.
- Only one patient was transfused with platelet concentrate (a case of electrical burn injury who underwent upper limb amputation with platelet count of 49,000/μL). All other patients had their platelet count above 10,000/ μL and were not transfused.
- Burns patients with wound infection had received a mean of 6.31 blood components while those without wound infection had received a mean of 2.74 blood components. **(P < 0.05)**

II. Factors influencing Length of Stay (LOS)

- The mean length of hospital stay was 22.39 days.
- APACHE II was positively correlated to LOS. **(P < 0.05)**
- The mean LOS of patient transfused with red blood cells was 26.39 days while patients who did not receive RBC transfusion had a mean LOS of 13.19 days. **(P < 0.05)**
- The mean LOS of patients receiving RBC units stored for < 14 days was 22.03 days while patients who received RBC units stored for > 14 days was 23.04. (P > 0.05)

- The mean LOS of patients receiving RBC units stored for < 21 days was 24.09 days while patients who received RBC units stored for > 21 days was 25.33. (P > 0.05)

- The mean LOS of burns patients with wound infection was 24.8 days while patients who did not develop wound infection had a mean LOS of 9.3 days. **(P < 0.05)**

- Mean LOS of burns patients with wound infection who had received RBC transfusion was 27.76 days. Mean LOS of burns patients with wound infection who had not received RBC transfusion was 15.6 days. **(P < 0.05)**

- The mean LOS of patients who underwent surgical procedures was 30.02 days while patients who were treated conservatively had a mean LOS of 15.24 days. **(P < 0.05)**

- Mean LOS of burns patients who underwent surgical procedures and had received RBC transfusion was 31.15 days. Mean LOS of burns patients with wound infection who had not received RBC transfusion was 15.6 days. **(P < 0.05)**

- Age and % TBSA did not show significant correlation to LOS.

- The factors found to significantly increase length of stay of burns patients include APACHE II score at admission, blood transfusions, surgical procedures and wound infections. The factors not found to significantly influence length of stay were age of the burns patient, sex and storage age of red blood cells.

CONCLUSION

In our study, by following hemoglobin trigger of 10 gm/dL for burns patients, use of red cell concentrate in 64% transfusions were considered appropriate. However, the remaining 36% were considered inappropriate because they were transfused for higher Hemoglobin values and with an aim to achieve faster wound healing.

In a country like India, considering the cost of 5% Albumin, as per original parkland formula, 47% of FFP transfusions were appropriate. The remaining 53% were considered inappropriate, because most of the units were transfused after 48 hours of burn injury and number of units transfused was inadequate for the expected dose of albumin to be replaced.

As in other studies, in our study also Length of Stay for burns patients significantly increases following blood component transfusion. Hence, judicious use of blood and blood components in burns patients must be emphasized.

Further, our study reiterates that there is no significant correlation between LOS and storage age of red cells in burns patients. This is contrary to the wider belief of using fresher whole blood to reduce length of hospital stay in burns patients.

Successful outcome of burns patients purely depend on proper wound care, along with appropriate use of fluids and blood components.

LIMITATIONS

- Burns patients with TBSA of more than 40% could have been included.
- If the patients were affordable, comparison of FFP transfusion with 5% albumin could have been done.
- Since patients with >40% TBSA were not included, appropriate use of platelet concentrates and other components like cryoprecipitate couldn’t be studied.

MASTER CHART FOR VARIABLES INFLUENCING LENGTH OF STAY

Study	Present study	Lelubre *et al*. 1	Poslu zny *et al*. 5 (n = 60)	Gupta *et al*. 14 (n = 892)	Tyson *et al*. 17 (n = 454)	Lu. *et al*. 22 (n = 89)	Palmieri *et al*. 39 (n = 666)	Neamtu *et al*.41 (n = 75)	Pettila *et al*. 44 (n = 757)	AABB 45	Cochrane 46	Aubron *et al*.47	Hashmi *et al*. 50 (n = 1597)	Roubinian *et al*. 53 (n = 275874)	Chakraborty *et al*.61 (n=83)	Bain et al.62 (n=2499)	Edgar *et al*.63 (n=1051)	Vincent *et al*.79 (n=1136)	Malone *et al*.80 (n=15534)	Sarani *et al*. 83 (n=380)	Hussain *et al*. 85
Age	35.38	-	-	35	-	48.3	-	-	-	-	-	-	22	-	-	26	-	-	-	-	-
Sex	M	-	-	M	-	M	-	-	-	-	-	-	M	-	F	F	-	-	-	-	-
Cause	Thermal	-	-	Thermal	Scalds	Thermal	-	-	-	-	-	-	-	-	-	Thermal	-	-	-	-	-
LOS	22.39	-	-	57	-	-	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-
Blood unit per pt.	5.75	-	16.6	8	-	6	13.7	-	-	-	-	-	-	-		-	-	4.8	-	-	-
Age vs. LOS	LOS Not prolonged	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Prolonged	-	-	-	Prolonged
RBC vs. LOS	LOS More	-	-	-	-	More	More	More	-	-	-	-	-	More	-	-	-	More	More	-	-
FFP vs. LOS	LOS reduced	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LOS prolonged	-
RBC vs. sepsis	Risk more	Risk more	Risk more	-	-	Risk More	Risk more	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sepsis vs. LOS	LOS Prolonged	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Prolonged	-
Surgery vs. Txn	Txn more in surgery	-	Txn more	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Surgery vs. LOS	LOS Prolonged	-	Prolonged	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	
Storage age of RBC	14-21 days	-	-	-	-	-	-	-	-	-	-	16-21	-	-	-	-	-	16.2	-	-	-
Storage age of RBC vs. LOS	LOS not prolonged	-	-	-	-	-	-	Prolonged	Prolonged	Not prolonged	Not prolonged	-	-	-	-	-	-	-	-	-	-

MASTER CHART FOR APPROPRIATENESS OF BLOOD COMPONENT UTILIZATION

Study	Present study	Posluzny *et al.* 5 (n = 60)	Gupta *et al.* 14 (n = 892)	Palmieri *et al.* 39 (n = 666)	Vincent *et al.* 79 (n = 1136)	Roubinian *et al.* 53 (n = 275874)	French *et al.* 54 (n = 1808)	Afzal *et al.* 55 (n = 350)	Kulkarni *et al.* 56 (n = 945)	Sarani *et al.* 85 (n = 380)	Schofield *et al.*59 (n = 1147)
Hb	12.53	-	-	-	11.3	-	-	-	-	-	-
Mean RBC unit per pt.	5.75	16.6	8	13.7	4.8	-	-	-	-	-	-
Mean FFP	3.61	-	-	-	-	-	-	-	-	4	-
Mean pre – Txn Hb	9.67	-	-	-	8.4	8.1	-	-	-	-	-
RBC appropriate txn	64%	-	-	-	-	-	97%	54.1%	-	-	-
FFP appropriate txn	47%	-	-	-	-	-	-	-	48%	-	63%
Platelet appropriate txn	100%	-	-	-	-	-	-	-	-	-	67%

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E-mail : mail@tnmgrmu.ac.in Fax : 91-44-22353698

INSTITUTIONAL ETHICS COMMITTEE

Address of Ethics Committee: The Tamilnadu Dr MGR Medical University Chennai, India	
Principal Investigator: Dr.J. Ravishankar , MBBS	
Proposal title: Evaluating the Appropriateness of blood component Utilization in burns patient Presenter: Dr.J. Ravishankar, MBBS (ECMGR0309034)	
Documents filed	✓
Protocol	✓
Informed consent documents	✓
Any other documents	

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INSTITUTIONAL ETHICS COMMITTEE

NAME OF MEMBER	DESIGNATION	SIGNATURE
Prof. D. SHANTHARAM **M.D., D. Diab** VICE CHANCELLOR, THE T.N. DR.MGR MEDICAL UNIVERSITY	**Chairman**	19/6/14
MR. ANAND DAVID UNIVERSITY STANDING COUNSEL THE T.N. DR.MGR MEDICAL UNIVERSITY	**Member**	
Dr. GEETHALAKSHMI, MD PhD DIRECTOR OF MEDICAL EDUCATION, CHENNAI.	**Member**	A
Dr. PERIANDAVAR MD INSTITUTE OF DIABETOLOGY GOVERNMENT GENERAL HOSPITAL, CHENNAI	**Member**	
DR.SABARATNAVEL, MD DEPARTMENT OF MEDICINE, GOVERNMENT HOSPITAL, ROYAPETTAH.	**Member**	
DR. SARAVANAN MDS. DEPT. OF ORAL SURGERY GOVERNMENT DENTAL COLLEGE, CHENNAI	**Member**	A
DR. M. LOGAMANIAN, M.D.,Ph.D. NATIONAL INSTITUTE OF SIDDHA, CHENNAI.	**Member**	19/6/14
Dr. R. P. ILANGHO, M.D DEPT. OF RESPIRATORY MEDICINE, APOLLO HOSPITAL, CHENNAI.	**Member**	
Dr. S. MINI JACOB, M.D DEM, THE T.N. Dr. MGR MEDICAL UNIVERSITY	**Member Secretary**	19/6/14

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DECISION

Opinion of the institutional Ethics Committee-PLEASE CHECK ONE

✓ Approved

_____ Modification required prior to approval (please specify on the space below)

_____ Disapproved

Date of review: 19/6/14

Signed : _____ (please print name) DR. D. SHANTHARAM
(please delete as appropriate, Chairperson, Secretary)

Modification needed Age to be modified
The Study should be done in the National Institute of Siddha instead of Chennai Corporation schools.
The pilot study should be done in adults.

The research proponent is hereby informed that the Institutional Ethics Committee will require the following:

1) All adverse drug reaction (ADRs) that are both serious and unexpected to be reported promptly to the IEC within 7 working days.

2) The progress report to be submitted to the IEC at least annually.

3) Upon completion of the study, a final study status report to submitted to the IEC.

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Assignment Inbox: The Tamil Nadu Dr.M.G.R.Medical Uty 2014-15 Examinations

	Info	Dates	Similarity	
TNMGRMU EXAMINATIONS	ⓘ	Start 01-Sep-2014 11:27AM Due 30-Oct-2015 11:59PM Post 30-Oct-2015 12:00AM	22%	Resubmit View

INSTITUTIONAL ETHICAL COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Ref.No.6371/ME-1/Ethics/2014 Dt:04.09.2014.
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A Study of evaluating the appropriateness of Blood Component utilization in burn patients " – For Project Work submitted by Dr.J.Ravishankar, MD (IH & BT), Dept. of Transfusion Medicine, PG Student, TN MGR Medical University, Chennai-32.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

GOVT. KILPAUK MEDICAL COLLEGE
29 SEP 2014
Kilpauk, Chennai-10.

29/9/14

CHAIRMAN,
Ethical Committee
Govt.Kilpauk Medical College,Chennai

26/9/2014
29/9/14

PATIENT INFORMATION SHEET

EVALUATING THE APPROPRIATENESS OF BLOOD COMPONENT UTILIZATION IN BURN PATIENTS

Burn injuries are a major public health problem due to its high mortality, morbidity and disability. This study is done to evaluate the appropriateness of Blood component utilization in Burn patients and to form a protocol for transfusion of blood components.

PROCEDURE

Data will be collected from Case records, Blood request forms and Blood Bank records for analysis.

BENEFITS AND RISKS

There is no risk for patients enrolled in this study as their treatment protocols are not interfered with.

CONFIDENTIALITY

Your privacy will be protected in so for as permitted by law. Only your researcher and Ethical committee members will have access to the data collected during the study.

PARTICIPATION

Your participation in this study is voluntary and you are free to decide now or later whether to continue or discontinue from the study.

CONSENT

I confirm that I read and understood the information about the above research study dated _____ and I received chance to ask the questions.

My participation in this study is voluntary and I know that I am free to withdraw from the study at any time, without giving any reason and without affecting of my legal rights.

I agree to this access. I know that my identification will not be revealed in any details that is released to third persons or published.

I agree not to restrict or interfere with any data or results that are obtained from this study. I agree to participate in this research study for the above listed purpose.

Patient's name :
Signature : Date :
Patient IP Number :

Signature of the person
who obtains consent : Date :

gq;Nfwghsu;f;fhd jfty; gbtk.

jffhak fzl Nehahs;fSfF ,ujjf$Wfs nrYjJtj;d Kiwahd jdik Fw;jJ fzlw;Ak MaT.

Fw;f;Nfhs:

jffhak fzl Nehahs;fSfF nrYjjggLk ,ujjf$Wfs kwWk mtww;d Kiwahd jdik fzlw;jy.

nra;Kiw:

Nehahs;fs;d kUjJtkid Fw;gNgLfs ,ujjf$Wfs Ntzb t;z zggqfs kwWk ,ujj tqf;a;y css Fw;gGfs Mf;ait ngwggl;L MaTfF clgLjjggLk.

gyd;fSk; ghj;gGfSk:

jffhak fzl Nehahs;fSfF ,ujjf$Wfs nrYjJtij ,ej MaT KiwggLjj cjTk. Nehahs;fs;d r;f;rir Kiwa;Nyh ,ujjf$Wfs nrYjjggLtj;Nyh Muharr;ahsu jiya;Ltj;yiy. Mifahy Nehahs;fSfF vttj ghj;gGk ,yiy.

,ufr;ag; ghJfhgG:

rll tiuKiwa;dgb jqfs;d nrhej t;aqfs ghJfhffggLk. jqfs;d Muharr;ahsH klLk ,ej Muharr;a;d NghJ f;ilfFk Gss; t;tuqfis gadgLjj ,aYk.

gq;fs;gG:

,ej Muharr;a;y jqfs;d gqfs;gG jddhutkhdJ. ,ej Muharr;a;y jqfs;d gqfs;gg;idj njhlutjwFk› t;LgLtjwFk vej NeuKk jqfSfF cu;ikAzL.

Nehahs;a;d; ngau:

ifnahggk;

Njj;:

Patient ID	Age (in yrs)	Sex	TBSA (in %)	Bl gp Rh typ	Hgb (in gm%)	Plt count (in cells/ cu.mm)	aPTT (in sec) N:- 30 - 40 sec)	WB units	PRBC units	FFP units (> 24 hrs post burn)	PC (RDP units)	WB + PRBC (units)	Appropriateness of RBC Txn	Appropriate RBC Txn (No. Of units) (Hb < 10 gm%, Hb > 10 gm%, surgery/ impending bleeds)	Inappropriate RBC txn (No. Of units) (> 10 gm%, no surgery/ impending bleeds)	Appropriate FFP Txn	Inappropriate FFP Txn	Outcome
B001	45	M	18	B pos	12.9	155000	32	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B002	61	M	15	B pos	10.7	330000	34	1	0	2	0	1	App. Txn	1	0	0	2	Survived
B003	38	M	25	A pos	15	276000	32	1	0	8	0	1	Inapp. Txn	0	1	4	4	Survived
B004	20	M	27	O pos	16.1	209000	33	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B005	65	M	27	B pos	13	94000	35	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B006	26	M	23	B pos	17	145000	37	17	8	7	1	25	Both App an	23	2	4	3	Survived
B007	30	F	38	O pos	13.9	220000	38	7	0	8	0	7	Both App an	6	1	3	5	Survived
B010	35	M	39	A pos	16	165000	32	1	0	0	0	1	Inapp. Txn	0	1	0	0	Survived
B011	72	F	21	O pos	10.1	197000	36	0	2	1	0	2	App. Txn	2	0	0	1	Survived
B012	30	F	27	O pos	13	100000	39	3	3	3	0	6	App. Txn	6	0	0	3	Survived
B013	25	F	33	O pos	9.3	209000	35	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B014	16	F	15	B pos	10.8	179000	36	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B015	25	F	26	B pos	13.1	122000	32	3	0	2	0	3	App. Txn	3	0	0	2	Survived
B016	35	M	40	O pos	14.1	79000	39	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B017	33	M	25	O pos	11.3	129000	34	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B018	32	M	27	O pos	12	110000	33	0	0	0	0	0	No RBC Txn	0	0	0	0	Survived
B019	29	M	17	B pos	13	495000	31	3	0	0	0	3	App. Txn	3	0	0	0	Survived
B020	46	M	20	A pos	16	141000	35	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B021	22	M	15	O pos	14.5	127000	35	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B022	42	F	17	B pos	14.8	276000	31	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B024	27	M	28	O pos	12.4	366000	32	0	0	2	0	0	No RBC Txn	0	0	0	2	Survived
B025	23	F	20	B pos	13	249000	34	2	2	1	0	4	Both App an	3	1	0	1	Survived
B027	29	F	32	AB pos	9.9	300000	36	5	0	3	0	5	App. Txn	5	0	2	1	Survived
B028	46	M	18	B pos	8.5	387000	37	5	1	0	0	6	Both App an	5	1	0	0	Survived
B029	40	M	27	B pos	14	239000	35	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B030	19	M	36	AB pos	10.1	179000	33	1	0	2	0	1	Inapp. Txn	0	1	2	0	Survived
B031	40	M	19	O pos	9	159000	32	2	2	0	0	4	App. Txn	4	0	0	0	Survived
B032	40	M	30	A pos	12.5	112000	37	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B033	24	M	31	B pos	15.1	222000	35	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B034	27	F	27	O pos	14.4	278000	34	1	0	4	0	1	App. Txn	1	0	2	2	Survived
B035	28	F	26	B pos	11	251000	34	3	1	2	0	4	App. Txn	4	0	2	0	Survived
B036	21	F	28	A pos	14.3	265000	35	1	1	6	0	2	App. Txn	2	0	4	2	Survived
B037	55	F	25	A pos	12	186000	33	3	0	10	0	3	App. Txn	3	0	4	6	Survived
B038	50	F	20	B pos	14	33000	38	2	1	2	0	3	App. Txn	3	0	0	2	Survived
B039	17	F	21	O pos	13.9	445000	32	3	0	2	0	3	Both App an	2	1	2	0	Survived
B040	55	M	23	B pos	9.2	106000	33	4	1	6	0	5	App. Txn	5	0	2	4	Survived
B041	37	M	33	B pos	11.4	192000	34	1	0	2	0	1	Inapp. Txn	0	1	2	0	Survived
B042	34	M	34	O pos	16	177000	35	4	2	3	0	6	Both App an	3	3	2	1	Survived

B043	33	M	22	O pos	15.6	164000	35	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B044	60	F	29	B pos	8	151000	36	2	2	4	0	4	App. Txn	4	0	2	2	Survived
B046	38	F	32	O pos	11	259000	34	6	3	5	0	9	Both App ar	5	4	2	3	Survived
B048	24	F	36	O pos	12	34000	38	4	4	5	0	8	App. Txn	8	0	2	3	Survived
B049	28	F	30	B pos	11.4	125000	36	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B050	29	F	30	O pos	13	217000	34	0	0	6	0	0	No RBC Txn	0	0	2	4	Survived
B051	60	M	26	O pos	12.6	209000	35	1	2	3	0	3	App. Txn	3	0	2	1	Survived
B052	48	M	23	O pos	15	442000	38	0	2	2	0	2	Inapp. Txn	0	2	2	0	Survived
B053	54	M	24	B pos	11	341000	38	1	0	4	0	1	Inapp. Txn	0	1	2	2	Survived
B054	40	F	40	B pos	13.3	349000	37	2	0	2	0	2	App. Txn	2	0	2	0	Survived
B055	39	F	31	A pos	12.9	212000	36	3	0	5	0	3	Both App ar	1	2	3	2	Survived
B056	38	F	33	B pos	13.5	221000	37	3	1	5	0	4	Both App ar	3	1	3	2	Survived
B057	45	M	15	A pos	14.5	194000	36	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B058	50	M	25	O pos	15	131000	35	0	0	3	0	0	No RBC Txn	0	0	2	1	Survived
B059	31	M	17	O neg	14.3	190000	36	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B060	28	F	25	O pos	8.5	285000	37	0	1	0	0	1	App. Txn	1	0	0	0	Survived
B061	24	F	32	A neg	11.2	237000	38	0	0	3	0	0	No RBC Txn	0	0	2	1	Survived
B062	61	F	20	O pos	11.2	54000	36	0	0	3	0	0	No RBC Txn	0	0	2	1	Survived
B063	25	F	25	B pos	14.3	138000	33	4	1	5	0	5	App. Txn	5	0	0	5	Survived
B064	18	F	25	B pos	15.9	572000	32	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B065	29	F	34	B pos	11.9	297000	34	4	4	11	0	8	App. Txn	8	0	4	7	Survived
B067	40	M	20	B pos	10.8	483000	37	4	3	6	0	7	App. Txn	7	0	3	3	Survived
B068	36	F	33	B pos	12.7	273000	35	2	0	6	0	2	App. Txn	2	0	3	3	Survived
B069	45	M	18	A pos	11.1	448000	32	2	2	4	0	4	Inapp. Txn	0	4	0	4	Survived
B070	26	F	26	AB pos	10.5	100000	33	0	0	6	0	0	No RBC Txn	0	0	2	4	Survived
B071	81	F	27	O neg	6.6	174000	34	0	2	2	0	2	App. Txn	2	0	2	0	Survived
B072	26	F	30	B pos	11.5	236000	36	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B073	40	F	30	B neg	10.7	111000	34	2	1	2	0	3	Both App ar	2	1	2	0	Survived
B074	19	F	20	AB pos	9.5	210000	33	4	0	6	0	4	Both App ar	2	2	2	4	Survived
B075	26	F	26	O neg	13.2	190000	33	2	1	8	0	3	Both App ar	2	1	3	5	Survived
B076	23	M	19	A pos	12	154000	34	7	1	8	0	8	Both App ar	2	6	2	6	Survived
B077	32	F	25	O pos	14.6	290000	34	1	0	4	0	1	App. Txn	1	0	2	2	Survived
B078	38	M	27	B neg	15.9	390000	32	3	0	10	0	3	Both App ar	2	1	6	4	Survived
B079	33	M	36	A pos	16.5	256000	33	1	0	2	0	1	Inapp. Txn	0	1	2	0	Survived
B080	18	M	38	O pos	7.4	264000	33	1	3	2	0	4	App. Txn	4	0	2	0	Survived
B081	30	F	32	O pos	9.7	103000	34	4	0	8	0	4	App. Txn	4	0	4	4	Survived
B082	42	M	20	O pos	16.3	277000	32	1	0	4	0	1	App. Txn	1	0	0	4	Survived
B083	22	M	31	A pos	15.4	95000	31	0	2	8	0	2	Both App ar	1	1	2	6	Survived
B084	27	M	30	O pos	12.4	157000	32	5	0	8	0	5	Both App ar	4	1	2	6	Survived
B085	40	M	19	A pos	12	146000	33	7	1	7	0	8	App. Txn	8	0	4	3	Survived
B086	30	M	30	O pos	14.3	132000	32	2	0	8	0	2	Both App ar	1	1	4	4	Survived
B087	35	M	22	A pos	12.3	660000	31	2	0	4	0	2	App. Txn	2	0	2	2	Survived
B088	52	M	34	B pos	18.1	233000	33	4	0	3	0	4	Both App ar	1	3	2	1	Survived
B091	17	F	27	B pos	16.4	239000	35	4	0	8	0	4	Inapp. Txn	0	4	2	6	Survived
B092	26	M	17	O pos	9.2	414000	32	7	0	2	0	7	Both App ar	6	1	2	0	Survived

B093	29	F	20	B pos	8	226000	36	1	2	2	0	3	App. Txn	3	0	2	0	Survived
B094	30	M	31	O pos	14	179000	34	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B095	26	M	20	O pos	15	83000	31	1	0	2	0	1	Inapp. Txn	0	1	2	0	Survived
B097	23	M	15	B pos	11	278000	3	3	0	1	0	3	Inapp. Txn	0	3	0	1	Survived
B098	23	F	23	O pos	12.1	128000	35	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B099	27	F	28	B pos	15.8	320000	31	5	5	9	0	10	Both App ar	8	2	4	5	Survived
B100	20	F	30	B pos	14	230000	32	1	1	3	0	2	App. Txn	2	0	2	1	Survived
B101	48	F	15	O pos	11.2	166000	32	1	0	2	0	1	App. Txn	1	0	0	2	Survived
B102	37	M	35	O pos	16.8	90000	34	4	0	5	0	4	Both App ar	3	1	0	5	Survived
B103	35	M	30	B pos	16.4	80000	35	0	0	2	0	0	No RBC Txn	0	0	0	2	Survived
B104	27	M	20	O pos	11.4	173000	36	1	0	3	0	1	App. Txn	1	0	2	1	Survived
B105	45	M	25	B pos	14.8	220000	35	1	0	2	0	1	Inapp. Txn	0	1	0	2	Survived
B106	25	F	27	B pos	8.9	243000	34	4	1	3	0	5	Both App ar	4	1	2	1	Survived
B107	25	M	20	B pos	13.9	158000	32	0	2	3	0	2	Inapp. Txn	0	2	0	3	Survived
B108	38	F	30	B pos	8.7	240000	35	5	2	0	0	7	Both App ar	5	2	0	0	Survived
B109	27	F	40	O pos	12	130000	33	3	0	7	0	3	Inapp. Txn	0	3	2	5	Survived
B111	26	F	28	O pos	12	108000	33	0	0	6	0	0	No RBC Txn	0	0	2	4	Survived
B112	39	F	20	O pos	13	204000	34	2	1	8	0	3	App. Txn	3	0	3	5	Survived
B113	70	F	37	B pos	10	171000	35	0	1	3	0	1	App. Txn	1	0	2	1	Survived
B114	30	M	35	O pos	14.6	156000	31	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B115	34	M	40	B pos	13.5	100000	32	2	0	6	0	2	App. Txn	2	0	2	4	Survived
B116	34	M	31	O pos	14.8	124000	33	2	0	2	0	2	Inapp. Txn	0	2	0	2	Survived
B118	22	F	15	O pos	10.6	130000	34	1	0	6	0	1	App. Txn	1	0	2	4	Survived
B119	24	M	15	B pos	15.7	182000	35	0	1	3	0	1	App. Txn	1	0	2	1	Survived
B120	40	F	35	O pos	9.6	235000	35	1	3	5	0	4	App. Txn	4	0	2	3	Survived
B122	50	M	37	O pos	13	160000	36	0	1	2	0	1	App. Txn	1	0	2	0	Survived
B123	20	M	15	A pos	13.6	271000	36	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B124	55	M	16	B pos	5.6	178000	35	5	5	0	0	10	Both App ar	9	1	0	0	Survived
B125	42	M	18	O pos	9.8	183000	36	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B126	50	M	30	A pos	10.6	170000	35	1	0	6	0	1	Inapp. Txn	0	1	4	2	Survived
B127	65	M	25	A pos	13.7	186000	35	1	0	3	0	1	App. Txn	1	0	2	1	Survived
B128	45	F	24	A pos	10.7	139000	36	6	0	5	0	6	Both App ar	5	1	2	3	Survived
B129	26	F	29	AB pos	10.7	219000	37	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B130	42	M	18	O pos	9.8	183000	38	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B131	25	F	18	B pos	11.4	51000	39	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B132	44	M	38	B pos	10	243000	34	2	0	6	0	2	App. Txn	2	0	3	3	Survived
B133	35	M	27	O pos	12	173000	33	1	0	4	0	1	Inapp. Txn	0	1	2	2	Survived
B134	40	M	20	A pos	17.1	175000	34	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B135	28	F	22	A pos	11	145000	35	1	0	2	0	1	App. Txn	1	0	2	0	Survived

Patient ID	Age (in yrs)	Sex	TBSA (in %)	Bl gp Rh typ	Hgb (in gm%)	Plt count (in cells/ cu.mm)	aPTT (in sec) N:- 30 - 40 sec)	WB units	PRBC units	FFP units (> 24 hrs post burn)	PC (RDP units)	WB + PRBC (units)	Appropriateness of RBC Txn	Appropriate RBC Txn (No. Of units) (Hb < 10 gm%, Hb > 10 gm%, surgery/ impending bleeds)	Inappropriate RBC txn (No. Of units) (> 10 gm%, no surgery/ impending bleeds)	Appropriate FFP Txn	Inappropriate FFP Txn	Outcome
B001	45	M	18	B pos	12.9	155000	32	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B002	61	M	15	B pos	10.7	330000	34	1	0	2	0	1	App. Txn	1	0	0	2	Survived
B003	38	M	25	A pos	15	276000	32	1	0	8	0	1	Inapp. Txn	0	1	4	4	Survived
B004	20	M	27	O pos	16.1	209000	33	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B005	65	M	27	B pos	13	94000	35	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B006	26	M	23	B pos	17	145000	37	17	8	7	1	25	Both App an	23	2	4	3	Survived
B007	30	F	38	O pos	13.9	220000	38	7	0	8	0	7	Both App an	6	1	3	5	Survived
B010	35	M	39	A pos	16	165000	32	1	0	0	0	1	Inapp. Txn	0	1	0	0	Survived
B011	72	F	21	O pos	10.1	197000	36	0	2	1	0	2	App. Txn	2	0	0	1	Survived
B012	30	F	27	O pos	13	100000	39	3	3	3	0	6	App. Txn	6	0	0	3	Survived
B013	25	F	33	O pos	9.3	209000	35	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B014	16	F	15	B pos	10.8	179000	36	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B015	25	F	26	B pos	13.1	122000	32	3	0	2	0	3	App. Txn	3	0	0	2	Survived
B016	35	M	40	O pos	14.1	79000	39	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B017	33	M	25	O pos	11.3	129000	34	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B018	32	M	27	O pos	12	110000	33	0	0	0	0	0	No RBC Txn	0	0	0	0	Survived
B019	29	M	17	B pos	13	495000	31	3	0	0	0	3	App. Txn	3	0	0	0	Survived
B020	46	M	20	A pos	16	141000	35	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B021	22	M	15	O pos	14.5	127000	35	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B022	42	F	17	B pos	14.8	276000	31	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B024	27	M	28	O pos	12.4	366000	32	0	0	2	0	0	No RBC Txn	0	0	0	2	Survived
B025	23	F	20	B pos	13	249000	34	2	2	1	0	4	Both App an	3	1	0	1	Survived
B027	29	F	32	AB pos	9.9	300000	36	5	0	3	0	5	App. Txn	5	0	2	1	Survived
B028	46	M	18	B pos	8.5	387000	37	5	1	0	0	6	Both App an	5	1	0	0	Survived
B029	40	M	27	B pos	14	239000	35	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B030	19	M	36	AB pos	10.1	179000	33	1	0	2	0	1	Inapp. Txn	0	1	2	0	Survived
B031	40	M	19	O pos	9	159000	32	2	2	0	0	4	App. Txn	4	0	0	0	Survived
B032	40	M	30	A pos	12.5	112000	37	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B033	24	M	31	B pos	15.1	222000	35	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B034	27	F	27	O pos	14.4	278000	34	1	0	4	0	1	App. Txn	1	0	2	2	Survived
B035	28	F	26	B pos	11	251000	34	3	1	2	0	4	App. Txn	4	0	2	0	Survived
B036	21	F	28	A pos	14.3	265000	35	1	1	6	0	2	App. Txn	2	0	4	2	Survived
B037	55	F	25	A pos	12	186000	33	3	0	10	0	3	App. Txn	3	0	4	6	Survived
B038	50	F	20	B pos	14	33000	38	2	1	2	0	3	App. Txn	3	0	0	2	Survived
B039	17	F	21	O pos	13.9	445000	32	3	0	2	0	3	Both App an	2	1	2	0	Survived
B040	55	M	23	B pos	9.2	106000	33	4	1	6	0	5	App. Txn	5	0	2	4	Survived
B041	37	M	33	B pos	11.4	192000	34	1	0	2	0	1	Inapp. Txn	0	1	2	0	Survived
B042	34	M	34	O pos	16	177000	35	4	2	3	0	6	Both App an	3	3	2	1	Survived

B043	33	M	22	O pos	15.6	164000	35	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B044	60	F	29	B pos	8	151000	36	2	2	4	0	4	App. Txn	4	0	2	2	Survived
B046	38	F	32	O pos	11	259000	34	6	3	5	0	9	Both App ar	5	4	2	3	Survived
B048	24	F	36	O pos	12	34000	38	4	4	5	0	8	App. Txn	8	0	2	3	Survived
B049	28	F	30	B pos	11.4	125000	36	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B050	29	F	30	O pos	13	217000	34	0	0	6	0	0	No RBC Txn	0	0	2	4	Survived
B051	60	M	26	O pos	12.6	209000	35	1	2	3	0	3	App. Txn	3	0	2	1	Survived
B052	48	M	23	O pos	15	442000	38	0	2	2	0	2	Inapp. Txn	0	2	2	0	Survived
B053	54	M	24	B pos	11	341000	38	1	0	4	0	1	Inapp. Txn	0	1	2	2	Survived
B054	40	F	40	B pos	13.3	349000	37	2	0	2	0	2	App. Txn	2	0	2	0	Survived
B055	39	F	31	A pos	12.9	212000	36	3	0	5	0	3	Both App ar	1	2	3	2	Survived
B056	38	F	33	B pos	13.5	221000	37	3	1	5	0	4	Both App ar	3	1	3	2	Survived
B057	45	M	15	A pos	14.5	194000	36	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B058	50	M	25	O pos	15	131000	35	0	0	3	0	0	No RBC Txn	0	0	2	1	Survived
B059	31	M	17	O neg	14.3	190000	36	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B060	28	F	25	O pos	8.5	285000	37	0	1	0	0	1	App. Txn	1	0	0	0	Survived
B061	24	F	32	A neg	11.2	237000	38	0	0	3	0	0	No RBC Txn	0	0	2	1	Survived
B062	61	F	20	O pos	11.2	54000	36	0	0	3	0	0	No RBC Txn	0	0	2	1	Survived
B063	25	F	25	B pos	14.3	138000	33	4	1	5	0	5	App. Txn	5	0	0	5	Survived
B064	18	F	25	B pos	15.9	572000	32	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B065	29	F	34	B pos	11.9	297000	34	4	4	11	0	8	App. Txn	8	0	4	7	Survived
B067	40	M	20	B pos	10.8	483000	37	4	3	6	0	7	App. Txn	7	0	3	3	Survived
B068	36	F	33	B pos	12.7	273000	35	2	0	6	0	2	App. Txn	2	0	3	3	Survived
B069	45	M	18	A pos	11.1	448000	32	2	2	4	0	4	Inapp. Txn	0	4	0	4	Survived
B070	26	F	26	AB pos	10.5	100000	33	0	0	6	0	0	No RBC Txn	0	0	2	4	Survived
B071	81	F	27	O neg	6.6	174000	34	0	2	2	0	2	App. Txn	2	0	2	0	Survived
B072	26	F	30	B pos	11.5	236000	36	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B073	40	F	30	B neg	10.7	111000	34	2	1	2	0	3	Both App ar	2	1	2	0	Survived
B074	19	F	20	AB pos	9.5	210000	33	4	0	6	0	4	Both App ar	2	2	2	4	Survived
B075	26	F	26	O neg	13.2	190000	33	2	1	8	0	3	Both App ar	2	1	3	5	Survived
B076	23	M	19	A pos	12	154000	34	7	1	8	0	8	Both App ar	2	6	2	6	Survived
B077	32	F	25	O pos	14.6	290000	34	1	0	4	0	1	App. Txn	1	0	2	2	Survived
B078	38	M	27	B neg	15.9	390000	32	3	0	10	0	3	Both App ar	2	1	6	4	Survived
B079	33	M	36	A pos	16.5	256000	33	1	0	2	0	1	Inapp. Txn	0	1	2	0	Survived
B080	18	M	38	O pos	7.4	264000	33	1	3	2	0	4	App. Txn	4	0	2	0	Survived
B081	30	F	32	O pos	9.7	103000	34	4	0	8	0	4	App. Txn	4	0	4	4	Survived
B082	42	M	20	O pos	16.3	277000	32	1	0	4	0	1	App. Txn	1	0	0	4	Survived
B083	22	M	31	A pos	15.4	95000	31	0	2	8	0	2	Both App ar	1	1	2	6	Survived
B084	27	M	30	O pos	12.4	157000	32	5	0	8	0	5	Both App ar	4	1	2	6	Survived
B085	40	M	19	A pos	12	146000	33	7	1	7	0	8	App. Txn	8	0	4	3	Survived
B086	30	M	30	O pos	14.3	132000	32	2	0	8	0	2	Both App ar	1	1	4	4	Survived
B087	35	M	22	A pos	12.3	660000	31	2	0	4	0	2	App. Txn	2	0	2	2	Survived
B088	52	M	34	B pos	18.1	233000	33	4	0	3	0	4	Both App ar	1	3	2	1	Survived
B091	17	F	27	B pos	16.4	239000	35	4	0	8	0	4	Inapp. Txn	0	4	2	6	Survived
B092	26	M	17	O pos	9.2	414000	32	7	0	2	0	7	Both App ar	6	1	2	0	Survived

B093	29	F	20	B pos	8	226000	36	1	2	2	0	3	App. Txn	3	0	2	0	Survived
B094	30	M	31	O pos	14	179000	34	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B095	26	M	20	O pos	15	83000	31	1	0	2	0	1	Inapp. Txn	0	1	2	0	Survived
B097	23	M	15	B pos	11	278000	3	3	0	1	0	3	Inapp. Txn	0	3	0	1	Survived
B098	23	F	23	O pos	12.1	128000	35	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B099	27	F	28	B pos	15.8	320000	31	5	5	9	0	10	Both App ar	8	2	4	5	Survived
B100	20	F	30	B pos	14	230000	32	1	1	3	0	2	App. Txn	2	0	2	1	Survived
B101	48	F	15	O pos	11.2	166000	32	1	0	2	0	1	App. Txn	1	0	0	2	Survived
B102	37	M	35	O pos	16.8	90000	34	4	0	5	0	4	Both App ar	3	1	0	5	Survived
B103	35	M	30	B pos	16.4	80000	35	0	0	2	0	0	No RBC Txn	0	0	0	2	Survived
B104	27	M	20	O pos	11.4	173000	36	1	0	3	0	1	App. Txn	1	0	2	1	Survived
B105	45	M	25	B pos	14.8	220000	35	1	0	2	0	1	Inapp. Txn	0	1	0	2	Survived
B106	25	F	27	B pos	8.9	243000	34	4	1	3	0	5	Both App ar	4	1	2	1	Survived
B107	25	M	20	B pos	13.9	158000	32	0	2	3	0	2	Inapp. Txn	0	2	0	3	Survived
B108	38	F	30	B pos	8.7	240000	35	5	2	0	0	7	Both App ar	5	2	0	0	Survived
B109	27	F	40	O pos	12	130000	33	3	0	7	0	3	Inapp. Txn	0	3	2	5	Survived
B111	26	F	28	O pos	12	108000	33	0	0	6	0	0	No RBC Txn	0	0	2	4	Survived
B112	39	F	20	O pos	13	204000	34	2	1	8	0	3	App. Txn	3	0	3	5	Survived
B113	70	F	37	B pos	10	171000	35	0	1	3	0	1	App. Txn	1	0	2	1	Survived
B114	30	M	35	O pos	14.6	156000	31	0	0	1	0	0	No RBC Txn	0	0	0	1	Survived
B115	34	M	40	B pos	13.5	100000	32	2	0	6	0	2	App. Txn	2	0	2	4	Survived
B116	34	M	31	O pos	14.8	124000	33	2	0	2	0	2	Inapp. Txn	0	2	0	2	Survived
B118	22	F	15	O pos	10.6	130000	34	1	0	6	0	1	App. Txn	1	0	2	4	Survived
B119	24	M	15	B pos	15.7	182000	35	0	1	3	0	1	App. Txn	1	0	2	1	Survived
B120	40	F	35	O pos	9.6	235000	35	1	3	5	0	4	App. Txn	4	0	2	3	Survived
B122	50	M	37	O pos	13	160000	36	0	1	2	0	1	App. Txn	1	0	2	0	Survived
B123	20	M	15	A pos	13.6	271000	36	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B124	55	M	16	B pos	5.6	178000	35	5	5	0	0	10	Both App ar	9	1	0	0	Survived
B125	42	M	18	O pos	9.8	183000	36	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B126	50	M	30	A pos	10.6	170000	35	1	0	6	0	1	Inapp. Txn	0	1	4	2	Survived
B127	65	M	25	A pos	13.7	186000	35	1	0	3	0	1	App. Txn	1	0	2	1	Survived
B128	45	F	24	A pos	10.7	139000	36	6	0	5	0	6	Both App ar	5	1	2	3	Survived
B129	26	F	29	AB pos	10.7	219000	37	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B130	42	M	18	O pos	9.8	183000	38	0	0	4	0	0	No RBC Txn	0	0	2	2	Survived
B131	25	F	18	B pos	11.4	51000	39	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B132	44	M	38	B pos	10	243000	34	2	0	6	0	2	App. Txn	2	0	3	3	Survived
B133	35	M	27	O pos	12	173000	33	1	0	4	0	1	Inapp. Txn	0	1	2	2	Survived
B134	40	M	20	A pos	17.1	175000	34	0	0	2	0	0	No RBC Txn	0	0	2	0	Survived
B135	28	F	22	A pos	11	145000	35	1	0	2	0	1	App. Txn	1	0	2	0	Survived